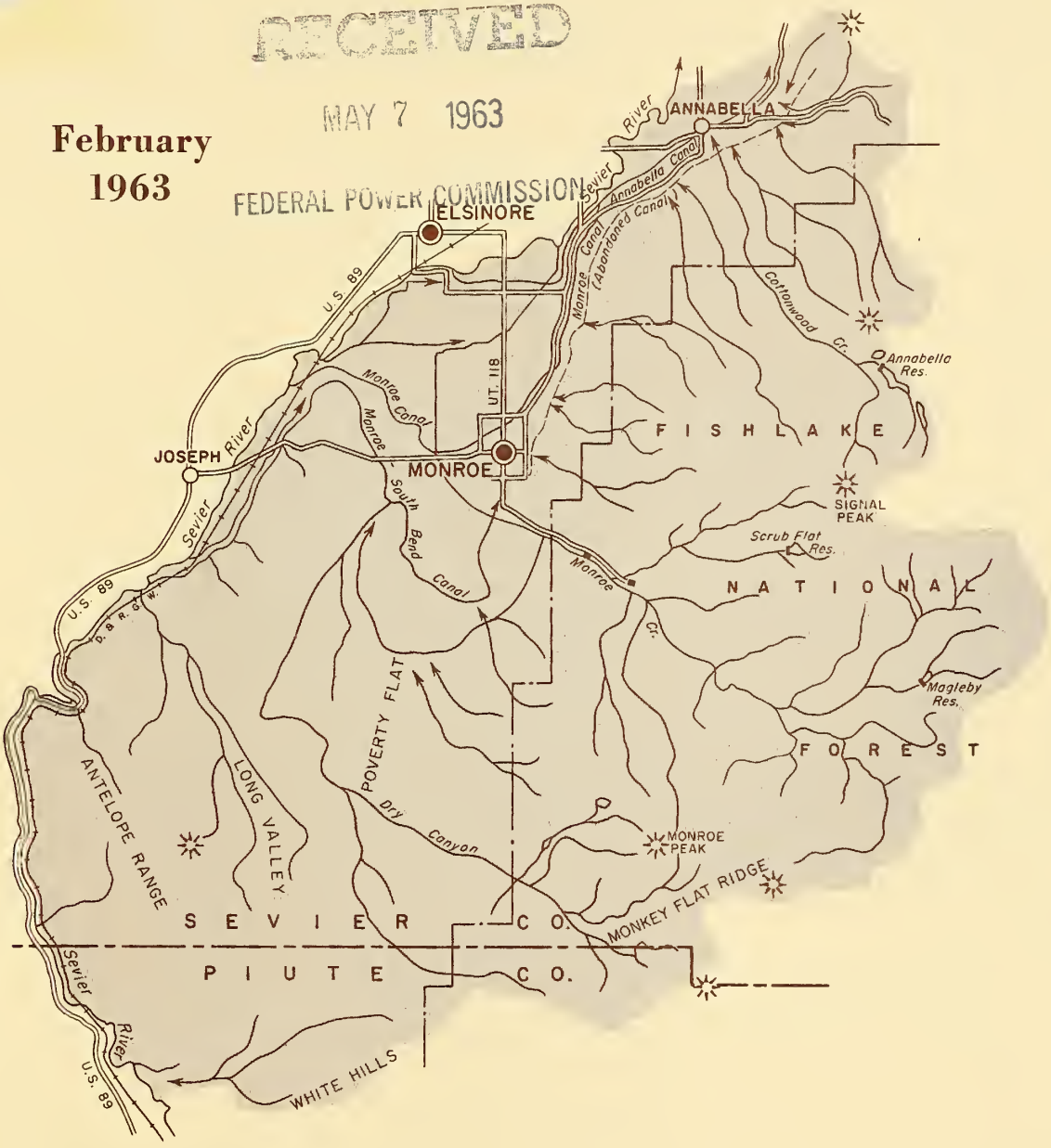
WATERSHED WORK PLAN

MONROE - ANNABELLA WATERSHED

SEVIER and PIUTE COUNTIES, UTAH

February 1963



Prepared under the authority of the Watershed Protection & Flood Prevention Act (Public law 566, 83rd. Congress, 68 Stat. 666) as amended.

M-3765

WATERSHED WORK PLAN

MONROE-ANNABELLA WATERSHED

Sevier and Piute Counties, Utah

Prepared Under the Authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83d Congress, 68 Stat. 666), as amended.

Prepared by: Sevier County Soil Conservation District
Monroe City
Utah State Department of Fish and Game
Annabella Irrigation Company
Dry Creek Irrigation Company
Monroe Irrigation Company

with assistance by:
U. S. Department of Agriculture, Soil Conservation Service
U. S. Department of Agriculture, U. S. Forest Service
U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service
U. S. Department of Interior, Bureau of Land Management
State of Utah, Water and Power Board
State of Utah, Land Board
State of Utah, State Engineer
State of Utah, Department of Forestry and Fire Control
State of Utah, Cooperative Extension Services

February 1963

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

THE WATERSHED WORK PLAN

MONROE-ANNABELLA WATERSHED

Sevier and Piute Counties, Utah

February 1963

SUMMARY OF THE PLAN

The Monroe-Annabella Watershed is located in southwestern Sevier County, with a small portion in northern Piute County, Utah. It is made up of approximately 109,125 acres of the central Sevier River drainage.

The work plan was prepared by the Sevier County Soil Conservation District, Monroe City, Utah State Department of Fish and Game, and the Monroe, Annabella, and Dry Creek Irrigation Companies.

Watershed Problems

Agricultural water management problems center around a short supply of late season irrigation water and high seepage and operational losses in distribution systems. These factors contribute to low on-farm irrigation efficiencies and limit the application of conservation treatment.

Most of the drainages rising in the mountains have a history of flooding. Because of the location of improved areas, only Sand, "H", Bertlesen, and Monroe canyons have a significant history of damaging floods. These floods have impaired the operation of the Monroe City municipal power plants and culinary pipeline, inundated portions of the city, and regularly damaged irrigation distribution systems. Floods caused the abandonment of the Annabella Extension Canal and some 200 acres of irrigated cropland in 1955. The town of Annabella has experienced limited flood damages from the steep canyon drainages east of the town.

Land deterioration on rangeland has resulted from declining vegetal cover due to a combination of overuse by livestock and big game. Range and watershed rehabilitation improvements are needed to halt deterioration and improve forage and soil resources. Limited upland game bird range and high mortality rate among bird broods restrict the area within which good game bird shooting can be improved.

Measures to be Installed

Works of improvement included in the plan are designed to improve the irrigation distribution and on-farm irrigation efficiencies, reduce flood and erosion damages, raise productivity of irrigated land, restore productivity of other watershed lands, and improve recreational resources. The estimated installation cost for the works of improvement included in the work plan is $2,615,890. The Federal (PL 566) share will be $1,402,150. The share from other funds will be $1,213,740. The work plan installation period is ten years. No additional land will be brought under irrigation as a result of the project.

Land Treatment Measures

Land treatment measures included in the plan are necessary to achieve the desired level of conservation development and for the effective operation of the structural measures. They will be installed on Private, State, and Federal lands.

Measures to be installed for improvement of irrigation efficiencies and conservation of soil and water on irrigated lands include such measures as conservation crop rotations, improved water management, ditch lining, and land leveling.

Critical area treatment to be installed fall into two general categories.

Measures in the first category are for critical area stabilization at higher elevations and include contour trenches, channel, road, and trail stabilization, seeding, fencing, and fire prevention and control.

Measures in the second category will arrest active gully erosion, reduce summer flood runoff and have a widespread effect in reducing land deterioration. They include sagebrush spraying, pinyon-juniper control, seeding, water development, and fencing.

The total installation cost for all land treatment measures is estimated to be $930,970 of which $269,490 or 29% will be from PL 566 funds and $661,480 or 71% will be from other funds. Technical assistance for accelerated land treatment costs will be borne by PL 566 funds on private and State lands.

Structural Measures

These measures will provide for more efficient use of the present water supplies and will supplement the land treatment program in reducing erosion, flood, and sediment damages. The recreational measures, three upland game bird watering facilities, will improve upland game bird hunter success. Structural measures include 72,020 feet of main and 68,480 feet of lateral canal lining, 31,300 feet of pipeline, three diversion structures, two debris basins above Monroe City, 1,815 feet of streambank protection work in lower Monroe Canyon, and three wildlife watering facilities. Total installation cost is $1,684,920 of which $1,155,450 is for agricultural

water management, $528,170 for flood prevention, and $1,300 is for the recreational measures. Public Law 566 funds will bear $618,990 and local funds will bear $536,460 of the installation cost for agricultural water management structural measures. Public Law 566 funds will bear $512,920 and local funds will bear $15,250 of the installation cost for flood prevention structural measures. Public Law 566 funds will bear $750 and other funds will bear $550 for the installation cost of recreational measures. The installation costs above include land rights and contract administration, all of which will be borne by non-Federal funds.

Benefits, Damage Reductions, and Costs

On-farm land treatment measures to be installed will bring about improved farm irrigation efficiencies on the 12,200 irrigated acres served by the 11 irrigation company systems in the watershed area. By the end of the installation period, average over-all farm efficiencies will have increased from 45-50% to the 55% level. The resulting reduction in gross irrigation requirements will enable farmers to make a more uniform application of existing water supply and is equivalent to an increase of 4% in effective headgate supply.

There will be a gross increase in headgate supply of about 13% from system improvements. This will give benefits of $95,200 per year. Average per acre production of principal farm crops will increase from 6% to 13%, depending on the crop. Taken together, the on-farm treatment and the system improvements will increase average net farm income by 23%, after costs of on-farm and structural measures are deducted.

Total annual benefits from the structural measures for flood prevention will amount to $28,245. This includes $21,360 in direct benefits from reduction of flood damages, and $6,885 in secondary benefits. Land treatment on critical areas will produce an additional $1,210 annually in flood damage reduction benefits, and $1,085 annually from reduction of gully erosion. The debris basins will give protection from 100-year frequency floods and contain sediment accumulation expected over a 50-year period. The streambank protection measures will give protection from the 50-year frequency summer flood and snowmelt flow. Primary damage items are enumerated and discussed under "Effects of Works of Improvement." The nature and magnitude of the damage items and benefits derived from the flood prevention structures and critical area treatment are shown in Table 5.

Total cost of the system improvement measures is $46,425 per year and the benefit-cost ratio is 2.1:1. Total costs of $20,745 per year are estimated for structural flood prevention measures with benefits of $28,245 annually. The benefit-cost ratio of these measures is 1.4:1. Total annual costs of $70 per year are estimated for the recreation measures with benefits of $300. The benefit-cost ratio of these measures is 4.3:1. Over-all ratio of benefits to costs of all structures is 1.8:1.

Project Installation and Financing

Sponsoring organizations will acquire necessary land and water rights, execute agreements with owners of private lands for installation of the land treatment measures, and provide the non-Federal share of the installa-

tion cost for project measures. Sponsoring organizations will contract for construction of the structural measures in the plan. Funds for payment of the non-Federal share of the installation costs, including repayment of loans for this purpose, will be provided through assessments of irrigation company stock, taxing authority of Monroe City, and contractual arrangements by the sponsors and water users. Legal authority for assessment, taxation, and contractual arrangement of these local organizations is adequate to meet financial responsibilities.

Operation and Maintenance

Annual operation and maintenance costs for structural measures are estimated to be $3,300.

Land treatment measures installed on private and State lands will be operated and maintained by the owners and operators under agreement with the Sevier County Soil Conservation District. Maintenance costs for land treatment measures to be installed on Federal land will be borne by Public Law 566 funds during the project installation period and thereafter from regular appropriations of the land administering agency.

Structural measures will be maintained by local sponsoring organizations. Specific responsibilities are outlined under "Provisions for Operation and Maintenance."

DESCRIPTION OF THE WATERSHED

Physical Data

The Monroe-Annabella Watershed is located in central Utah, in the southwestern part of Sevier County and in the extreme northern part of Piute County. The watershed covers approximately 109,125 acres of which 107,070 acres are in Sevier County and 2,055 acres are in Piute County. The project area is about 16 miles long and 10 to 12 miles wide. There are four communities in the watershed--the incorporated town of Annabella and Monroe City, and the unincorporated towns of Austin and Brooklyn. Monroe City is the largest with a population of about 900 people. Richfield, the county seat of Sevier County, is located about three miles northwest of the watershed.

The Sevier River forms the north and west boundaries of the watershed. A rugged divide along the crest of Cove and Monroe Mountains forms the east boundary. The south boundary is located north of Marysvale Peak and extends along the White Hills north of the town of Marysvale.

Streams in the watershed drain the steep west face of the Sevier Plateau, flowing west and north into the Sevier River. Monroe Creek, the largest drainage within the watershed, drains an area of some 41 square miles. Other principal drainages include Dry Canyon, Long Valley, Thompson, Cottonwood, and Maple Creeks. Numerous small drainages rise along the mountain face, the more prominent of which are: Live Oak, Corner, Bertlesen, Sand, "H", Order-Dugway, Winget, Jensen, Red Butte, and Cliff Canyons. These canyons are from 1½ to 4 miles long and drain areas of 200 to 2,000 acres. Bertlesen, Sand, "H", and Order-Dugway canyons drain directly toward the city of Monroe.

National Forest lands occupy 40,375 acres along the east side of the watershed. National Land Reserve (administered by the Bureau of Land Management) occupy 40,620 acres in an intermediate belt adjacent to and below the Fishlake National Forest, and in low foothills in the southern part of the watershed. State of Utah lands, comprising 6,620 acres, are interspersed among Federal and private lands. Private lands occupy 21,510 acres. Private land is mostly concentrated in a block located in the western and northwestern part of the watershed.

Elevations in the watershed range from over 11,200 feet on top of Monroe and Signal Peaks to approximately 5,300 feet along the Sevier River. Valley lands are made up of gently sloping flood plains located along the Sevier River and moderately to steeply sloping fans and benches located adjacent to the mountainous faces. Irrigated lands are generally below 5,600 feet in elevation.

The watershed contains approximately 12,200 acres of irrigated land, including 900 acres of pasture, some of which are slightly to moderately affected by water table and salinity. Slopes of the irrigated lands are mainly in the 0 to 5 per cent range, with long slopes and gently rolling topography predominating. Shallow gravelly to rocky alluvial fans and bench lands border the irrigated area on the east and southeast and is now used primarily for spring-fall range for livestock. The remainder of the watershed is steep, rocky foothills and mountains, important for timber, grazing, recreation, wildlife, and watershed purposes.

The Sevier River with its principal storage reservoirs, Piute and Otter Creek, is the principal source of irrigation water supply for the watershed. Storage and diversion of water on the Sevier River is in accordance with the Cox Decree. Water passing through or released from these reservoirs follows the natural course of the Sevier River to the points of diversion into the five principal irrigation company canals serving 85 per cent of the irrigated lands of the watershed.

Six small irrigation companies, serving 15 per cent of the irrigated area, divert their supply from streams and springs originating in the watershed. These streams and springs drain the east side of the watershed. Streams of local importance are Cottonwood, Dry Canyon, Live Oak Canyon, Monroe Creek, and Thompson Creek.

Generally, during July and August, most all irrigated areas experience a deficient water supply. The deficiency is greatest for the companies diverting their supply from drainages originating within the watershed.

Principal uses of available water supplies are irrigation, municipal, culinary, livestock, and water for hydroelectric power generation.

Mean annual precipitation in the cultivated area ranges from 8-10 inches, with about 60 per cent falling during the April-October growing season. Precipitation increases with elevation to 12 inches at 6,000 feet and to 30 inches at 10,000 feet, with the majority falling as snow. Violent thunderstorms which can produce torrential rains occur frequently in summer along the west face of the mountains. These storms are often the sources of major floods.

Mean monthly temperatures, during the growing period, vary from 48° in April to 72° in July, with 51° in October. Late spring frosts occasionally affect crop production. The mean length of frost-free period is approximately 130 days, based upon threshold temperatures of 32°F.

Soils

The irrigated soils are formed in materials derived from igneous and sedimentary rocks. These materials were deposited as flood plain and alluvial fan deposits on slopes ranging from 0 to 5 per cent. Most of the soils are deep, medium textured, and generally well drained.

Shallow soils underlain with beds of sand and gravel are prominent over about two square miles in the Brooklyn area. These pervious soils are on slopes ranging from 0 to 2 per cent.

North of Monroe, deep, imperfectly drained, silty clays cover an area of about one square mile. These soils have been improved by open drains; however, they do not produce crop yields comparable to those in adjacent areas.

Some wet, slightly saline soils are along the Sevier River on the north part of the watershed. These soils vary from sands to clays and are moderately permeable. They are used as pasture lands and are irrigated when water is available. The watertable in this wet area fluctuates somewhat with the flow of the Sevier River.

A belt of coarse to medium-textured porous soil lies adjacent to the foothill and mountain slopes. These soils were formed in materials deposited on alluvial plains and fans on slopes ranging from 0 to 10 per cent.

The rangeland soils have developed on colluvial and alluvial slopes ranging from 2 to 70 per cent. These soils are generally shallow and gravelly, and bedrock outcrops are common. A combination of inherently unstable soils and vegetal depletion by big game and livestock grazing has brought about moderate to severe erosion on many of the slopes.

Soils on the mountains are generally deep, medium to fine textured, and moderately permeable; however, shallow, gravelly, or cobbly soils occur on the steeper slopes. Generally, soils in the mountains support a good cover of vegetation except on the south and west facing slopes.

Economic Data

The population in the State of Utah has increased nearly 30 per cent during the decade 1950 to 1960. Both the Sevier County and the Watershed population has decreased 12 per cent during the same period. The 1960 census shows a total of 955 persons in the Monroe area and 177 in the Annabella area. These people live mostly in the towns and operate adjacent irrigated farms.

Land and water resources are utilized primarily for the production of feed and forage for sheep, beef cattle, and dairy herds. There are two turkey operators who produce 30,000 to 50,000 birds each per year. Cattle units are relatively small. Most of them range from 30 to 60 animal units in size. A few ranchers run from 50 to 100 head of cattle. Of the ten sheepmen operating within the watershed, one runs approximately 2,500 head, and the remainder own 200 to 500 breeding ewes. The small herds combine into three large cooperative bands during the summer grazing period on Federal and private lands.

The number of sheep has declined during the last 15 years. Poultry production has decreased by 30% over the same period. On the other hand, both total cattle numbers and cattle units per farm have increased. The total number of dairy cows has increased by about 12%. Concurrently, milk production per cow has increased 88%. Over-all, the ratio of livestock units to cropland acres has increased by 60% in the past 10 years, from .46 to 0.74 animal units per cropland acre.

Public lands are grazed in conjunction with private rangelands, both in and out of the watershed. The average permit on National Forest land in the watershed is for 37 animal units. Some Forest Service permittees also hold permits on the National Land Reserve (BLM lands) for spring-fall grazing. On BLM lands in the watershed, 27 permittees hold permits for 409 cattle and 3,110 sheep; but part of the grazing is on lands outside the watershed.

The watershed has 188 farms averaging 165 acres in size. This includes grazing land within or adjacent to the irrigated area. About 55% of the farms exceed 50 acres of irrigated land per farm. The over-all average is 65 acres. There is a slight trend toward an increase in the number of farms above 50 acres of irrigated cropland over the past 20 years. During the same period, there has been a 6% increase in farms of less than 20 acres of irrigated land. Many of the owners have leased to larger operators or are farming the small units on a part-time basis.

The principal agriculture products from the watershed are shipped both by truck and rail. Rail facilities for shipping sugar beets to the nearest processing factory at Gunnison, in nearby Sanpete County, are within a mile of the watershed boundaries. Nearly all other agricultural products such as cattle, sheep, wool, dairy products, poultry, and eggs are shipped by truck over improved highways. Surfaced highways connect Annabella and Monroe communities with U. S. Highway #89. Major all-weather surfaced highways lead west, south, and north from the watershed. Beef cattle and lambs are fattened in the area and sold in the Ogden and Salt Lake markets or shipped via truck or rail to the Pacific Coast. Dairy products are sold in Salt Lake City and Los Angeles, while eggs and turkeys mostly move to eastern markets. Some beef cattle and lambs are sold as feeders and shipped to Colorado or to Mid-West cornbelt farms for fattening. Potatoes are shipped to California and Arizona.

The values of irrigated land are based on soil, water rights, farm improvements, and associated rangelands. Deep, medium-textured soil with a full water right brings from $350 to $500 per acre depending on improvements and associated rangelands. Shallow, gravelly soils are valued at approximately $300 per acre. The grass and native meadow areas have a market value of around $200 per acre. Total value of an average farm is approximately $30,000.

Recreational resources are not developed in the watershed area to the extent that local people derive significant economic benefit from them. Water resources are utilized principally for irrigation. Upland game bird population and range is restricted because of limited available water along the frontal fans. There is limited fishing habitat with the watershed. The deer hunting season stimulates some trade in the community of Monroe, but little direct economic benefit is realized by farmers and ranchers. The picnic and camping areas in Monroe Canyon and adjacent mountains are used extensively by local people, but only limited use has been made of the area by tourists.

Commercial lumbering operations are carried on in a small way within the National Forest boundaries. Principal species available for lumber are aspen, douglas fir, engelman spruce, sub-alpine fir, and white fir. Considerable use of timber resources was made by local people during the early years of development, but many of the easily accessible stands have been cut, and much of the remaining timber is relatively inaccessible or is located on critical watershed land.

LAND OWNERSHIP

Owner	Acres	Per Cent of Total
Private	21,510	19.7
Public Federal		
National Forest	40,375	37.0
National Land Reserve (BLM)	40,620	37.2
Public Non-Federal		
State of Utah	6,620	6.1
Total	109,125	100.0

LAND USE - PRIVATE AND STATE LAND

Use	Acres	Percent
Irrigated Cropland	11,300	40.2
Irrigated Pasture (Native)	900	3.2
Total Irrigated Land	12,200	43.4
Rangeland	11,475	40.8
Woodland	4,230	15.0
Urban	225	0.8
Total	28,130	100.0

WATERSHED PROBLEMS

The important problems in the watershed include:

1. Agricultural water management problems, including seepage and operational losses in the distribution systems, the deficiency of late season irrigation water, and the management of the existing irrigation water supply.

2. Flood and sediment damage to the city of Monroe and Annabella town, to water and power facilities serving Monroe City, and to irrigation distribution systems located on the fringes of fans at the mouths of Monroe, Bertlesen, Sand, "H", and Order-Dugway canyons.

3. Erosion damage and range forage depletion on the National Forest, National Land Reserve, private and State rangelands; and

4. The progressive deterioration of mule deer winter range, the lack of stable streams and lakes for fishing, and watering facilities for upland birds and big game.

Agricultural Water Management Problems

Excepting that diverted from the small tributory drainages arising in the mountainous portion of the watershed, the major source of irrigation supply is from the Sevier River. Although all of the irrigation companies diverting out of the Sevier River have upstream storage in addition to direct flow rights, their total supply is seldom sufficient to furnish a full-season supply to all the irrigated lands served by the existing distribution systems.

During August, generally the month having the most deficient supply, the various irrigation companies have a present median supply which can irrigate from 16 to 74% of the irrigated cropland acreages under their respective systems. Median monthly farm headgate irrigation supplies, in acre feet per acre, are given for three irrigation companies in the watershed, in Irrigation Supply, under the AGRICULTURAL WATER MANAGEMENT section of the work plan.

A high spring snowmelt runoff in substantial excess of early season needs occurs during most years. In most years, the supply during July and August is insufficient to satisfy the irrigation requirements for all the cropland under all the systems. Generally the supply is sufficient up to the first of July, becoming deficient through the first part of September, and then adequate for the remainder of the fall.

This mid-season supply deficiency restricts the acreages of the late season crops, such as sugar beets, corn, potatoes, and new alfalfa or tame pasture. The full production of alfalfa and improved grass pastures are also seriously limited. Adoption of conservation crop rotation systems necessary to maintain and improve soil fertility are also hindered by the uncertain supply conditions.

Seepage and operational losses in the main canals are a watershed-wide problem. There are considerable lengths of main canals which cross the relatively permeable riverbottom alluvium. There are also many canals and ditches located on the coarse fan areas, below the mouths of the canyons on the south and east side of the irrigated area. The necessity of checking up the canals to deliver water to the turnouts supplying fields lying immediately below the canal, especially during periods of low supply, often causes serious operational difficulties. The need for drying-out the canals in mid-summer to control moss also in conducive to inefficient operation at a critical time of the season.

Soil and topographic conditions vary throughout the watershed and occur in complex combinations on individual farms and in restricted localities. Farm irrigation systems are designed to meet the prevailing soil and topographic complex to some degree. Nearly all farmers are carrying out continuing programs of water conservation improvements as rapidly as private finances and other assistance will permit. However, conservation needs surveys show that only 40 per cent of the conservation planning has been completed and that the application of the key conservation practices range from 8 to 44 per cent of the amounts needed. There is a corresponding lag in applying the practice of on-farm irrigation water management. Farm irrigation schedules taken in 1959, 1960, and 1961 show a spotty performance in this respect. Many farmers achieve average seasonal farm irrigation efficiencies of 50 to 55 per cent, but these records are marred by occasional field irrigation efficiencies of some 20 to 35 per cent on the same farms. The low irrigation efficiencies result from a combination of poor seasonal distribution of the water supply and an imperfect understanding of irrigation water management concepts among the farmers. There is a need for a vigorous educational program in this field.

Flood Problems

Although the drainages which descend from the steep and rocky front of Monroe and Cove Mountains give evidence of being consistent flood producers, most of the drainages debouche onto fan areas devoid of improvements and even massive floods are dissipated with but little damage. Three drainages, however, cause damage to Monroe City and important facilities serving the community. These are

1. Sand and "H" Canyons, directly east of Monroe City

2. Bertlesen Canyon to the southeast of Monroe City

3. Monroe Canyon, immediately south of Bertlesen Canyon

Six major and disastrous floods have damaged the Monroe community since before the turn of the century. Historical accounts list especially heavy floods in 1896, 1917, 1933, 1937, 1939, and 1943. Light to moderate damage occurred in 1947, 1953, 1954, and 1957. In addition to the recurring costs of sediment, floodwater, and debris damages in Monroe City during this period, the cumulative weight of flood damage to the Annabella-South Bend extension canal caused the company to abandon it in 1955 and build a new one at a location less susceptible to flood damage. It is estimated that the cost of cleaning the old canal after each flood, crop failures due to interruption of irrigation water delivery, the construction of a new canal, and the consequent abandonment of some of the land served by the old canal cost the stockholders of the company over $500,000 and materially retarded the normal development of the Annabella community.

At the same time, measures taken by the Annabella irrigators to operate and maintain the Annabella-South Bend extension canal gave an indirect but effective benefit to Monroe City. The Annabella Extension Canal skirts the fringe of Sand Canyon fan above Monroe City. It intercepts mud flows and siphons off flood peaks from Sand, "H", and Order-Dugway Canyon floods. Thus, the built-in protection afforded by the canal must be credited with curtailing large floods and eliminating damage to Monroe City from the more frequent but lighter floods. Although the canal has now been abandoned by the Annabella Irrigation Company, a short stretch of upper canal is still used to deliver irrigation water to about 90 acres of land northeast of Monroe City. Assuming the inevitable and imminent occurrence of a flood which will fill the canal as in the past, it is doubtful that the present users of the canal will find it economical to put it back into service. With the protective capacity of the canal expended, flood damages from Sand and "H" Canyons can be expected to increase substantially through a future period.

Bertlesen Canyon is a small drainage which produces one or more damaging floods nearly every year. Small floods block the ditch which conveys irrigation water to farmland and city garden plots in Monroe City. The larger floods block the ditch, deposit sediment and debris on farmlands, and flood the south part of the city on occasion. Most floods from this canyon occur during July or August when garden and agriculture water is in high demand.

Monroe Canyon is a narrow rocky gorge cut through the front of Monroe Mountain. The city culinary water originates here and is piped through the lower canyon to Monroe. Two city-owned hydroelectric plants are also located in the lower canyon. The principal access road to canyon recreational areas and to the grazing areas on the Sevier plateau along the crest of the mountain is also situated along the bottom of the lower canyon. Floods originating in the lower and intermediate reaches of the canyon carry large amounts of coarse sediments and debris through the narrow gorge and block or divert the creek against the pipelines and the road embankment. In spite of constant maintenance, the bottom of the canyon in lower reaches is progressively being eroded away and both the road and the pipeline are threatened.

Grazing and Related Problems

Dairy and poultry products, field crops, and beef and sheep raising are the chief sources of farm income. The average size of beef and sheep enterprises in the watershed is about 50 animal units, and the relatively small size of these enterprises underlines the importance of range grazing as a source of low cost forage. Most of them are dependent on range forage resources for an economic operation. Drought, uncertain markets, low prices, and forage declines due to overuse by big game and domestic livestock combine to create hydrologic and economic conditions which threaten the existence of these units.

Operators of range livestock units have made efforts in recent years to improve their ranges, and more and more of them are adopting better range management practices. Most of the fencing, seeding, and brush and tree removal have been done on private rangelands at elevations where favorable precipitation conditions assure successful establishment of the measures. However, only about 36 per cent of the 11,475 acres of privately and State owned rangeland is situated in the area which favors successful establishment. The balance of the private rangeland lies around the fringes of the irrigated area where rainfall and soil conditions decrease chances of successful application of range treatment. Private operators have been reluctant to assume these risks and it is doubtful that low lying private range resources will be improved much beyond their current condition.

Wildlife Problems

The principal game management problem in the watershed is the limited area of mule deer winter range. Overgrazing by both deer and livestock has resulted in a deteriorated condition of the winter range located between the farmlands and the steep mountain front. Winter deer losses are common, and continued grazing pressures on these areas will result in further deterioration unless action is taken to treat these lands and to apply better management methods to them. Successful treatment of the foothill area will improve the vegetal cover of the adjacent steep mountain front. Because of poor forage on the winter range, deer move up the mountain front before forage plants are ready in the spring; and much of the deterioration along the face of the mountains can be attributed to too early use by big game or domestic livestock.

Recreation Problems

Available water for upland game birds is presently inadequate along the foothills and frontal fans. This limits the range of the adult birds and contributes to a high mortality rate among newly hatched broods. The result is a low game bird population over these areas and poor hunter success.

PROJECTS OF OTHER AGENCIES

The proposed Monroe-Annabella Watershed Project is not in conflict with other proposed developments within the area.

As part of the initial phase of the Central Utah Project, Bureau of Reclamation, the feasibility of diverting water from the Colorado Basin into the lower Sevier Basin is now under study. Under the ultimate development phase of the Central Utah Project, a much larger amount of water may be diverted into the lower Basin. There is a possibility that this development may call for water exchanges along the Sevier River.

Land treatment and structural measures for agricultural water management installed on the Monroe-Annabella Watershed will facilitate and complement desirable adjustments in the watershed as induced by either phase of the Central Utah Project.

Existing soil and water conservation programs of local, State, and Federal agencies, including land administering agencies, will be complemented and materially assisted by treatment measures to be installed under this plan.

BASIS FOR PROJECT FORMULATION

Formulation of measures included in this plan are based upon an understanding of watershed problems, alternative measures effective in the solution of similar problems, and the objectives of local organizations with regard to intensity of treatment and level of protection.

The principal objectives of the sponsors are to effect the maximum conservation use of a short late season water supply and provide the maximum feasible degree of protection for Annabella and Monroe cities, city power plants and water supply lines, culinary waterlines, roads, irrigation distribution systems, farmlands, and cultural improvements from damaging floodwater and sediment. Other objectives are to protect the watershed lands from erosion and summer flood runoff, maintain and improve the productive capacity of the soil, and increase and stabilize farm income.

A coordinated plan for treatment of all watershed lands was developed to accomplish these objectives with optimum benefits. Treatment measures included in the plan are based upon extensive investigations of problems, cause and effect, and experience gained in other watersheds.

Land Treatment Measures

Land treatment measures, kinds and amounts, included in this plan for installation on private and State land were based on need, soil capabilities, land and water use, and the ability of the operators. The combination and amounts of measures selected will give the expected level of benefits from the structural program.

Kinds and amounts of land treatment measures for installation on Federal land represent an estimate of need based upon an analysis of problem areas and measures selected to alleviate watershed problems, adjusted to those which are feasible. These measures were selected to reduce sediment and summer flood runoff, prevent land deterioration, stabilize critical areas, and contribute to increased production of forage resources for livestock and big game. Treatment measures were jointly selected and evaluated by the land administering agencies, the Soil Conservation Service and local sponsors.

Land treatment measures included in the plan for installation on Utah State Department of Fish and Game land and State land leased by the Department are planned to prevent soil erosion and land deterioration. Need determination was based upon the present gully erosion and that expected if no treatment were made. The location of the treatment areas were selected to stabilize watershed land and to reduce summer flood runoff and erosion.

Structural Measures

Structural measures for agricultural water management were selected by the irrigation companies and informal groups from a number of alternative proposals designed to decrease water supply deficiency and to alleviate operation and maintenance problems.

Water supply deficiencies were determined by months for each irrigation system. These were based upon water supply available at the diversion point, conveyance and operational efficiencies of distribution systems, farm irrigation efficiencies, and consumptive use requirements of the crops.

Alternative solutions proposed to alleviate water deficiencies and operation and maintenance problems include lining of individual systems and system combinations where seepage loss measurements showed a need for lining, small storage reservoirs in the upper watershed, and new diversion structures at the head of each system.

The agricultural water management structural measures included herein were selected only after exhaustive evaluation and discussion of each proposal including the amount of water to be saved, reduction in operation and maintenance costs, benefits, installation costs, cost sharing, and the ability of each company or group to finance and repay their share of the installation cost allocated to them.

Storage facilities and combinations of systems were rejected in all cases because of high storage costs, questionable financial advantages in combinations, or water rights.

The structural measures for flood prevention included herein were selected after an analysis of alternatives for both the desired level of protection and benefits.

Interviews with local people and visual evidence revealed that almost all drainages rising within the watershed have a history of flooding. An analysis of damages and damageable values showed a wide disparity in justification for flood prevention structural measures. Outflows from some of the canyons spread across and dissipate on unimproved fan areas while others have a flood path across valuable farmland, irrigation distribution systems, roads, Annabella and Monroe cities, and community power and culinary water lines.

The history of damage to Monroe City, adjacent farmlands, and irrigation distribution systems is the basis for including the debris basins below Sand and "H" Canyons and Bertlesen Canyon east of Monroe City. The level of protection, 50-year sediment capacity and 100-year summer flood frequency detention, were agreed upon after consideration of increased cost for disposing of spillway releases for lower levels of protection. Alternative solutions, including debris basins and disposal channels, were evaluated. The sites selected represent the most feasible alternatives.

The history of repeated damage to roads, electric power plants, and water lines at essentially the same locations during summer flash floods is the basis for planning the streambank protection works in Monroe Canyon. Peak snowmelt flows aggrevate the points damaged by summer flash floods. Streambank protection measures included in the plan for installation in Monroe Canyon will provide protection from the 50-year frequency summer flash flood and all expected snowmelt peaks. Protection of the affected facilities from the 25-year frequency snowmelt peaks was evaluated as an alternative. An examination of installation costs, operation and maintenance costs (including replacement), remaining damages and benefits for the alternative solutions led to the selection of the design for protection against the 50-year frequency summer flash flood.

The watering facilities for upland game birds, a recreational measure, in the Anderson Canyon pipeline to be installed in cooperation with the Bureau of Land Management were planned to increase survival and expand the range of broods.

WORKS OF IMPROVEMENT TO BE INSTALLED

Land Treatment Measures

The kind, the amount, and the location of the land treatment measures to be installed under this plan is dictated by the nature and the magnitude of the problems presented and the areas where specific treatment is needed and appropriate. The measures proposed are made up of those which have proved to be effective and feasible under similar physical conditions in other locations or watersheds. The selection of these measures represents judgment and experience gained in dealing with watershed problems as described heretofore and the planned measures are in accord with treatment criteria outlined in the technical guide for the area. As treatment units, (groups of closely interdependent measures), they are designed to correct the dominant problem on each treatment area. They also contribute in some degree to the over-all goal of improving or preserving watershed resources and to using these resources to the fullest possible extent.

Critical area treatment in the upper watershed and foothill areas may be grouped into two general categories.

Measures in the first category include trenching, seeding, gully stabilization, fencing, and other erosion control measures. These are to be installed on critical flood and sediment source areas located predominantly at higher elevations. The primary effect will be to reduce summer flood runoff and sediment at downstream damage points where flood prevention structures are to be installed. This treatment will also prevent potential expansion of critical areas and will insure that design capacities of flood prevention structures are not overtaxed.

The second group of measures include sagebrush spraying, pinyon-juniper control, seeding, water developments, and fencing. These measures will arrest active gully erosion, reduce summer flood runoff, and have a widespread effect in reducing vegetal and land deterioration in the intermediate mountain areas.

Increased fire protection will be secured by installation of a radio-equipped pumper tanker and an improved fire suppression organization.

Land treatment in the valley will be chiefly confined to the irrigated cropland. The principal purpose of these measures is to improve farm irrigation efficiency. They will also improve soil fertility, increase crop yields, and reduce labor inputs. An added and important effect will be more efficient utilization of the increased headgate supply developed through canal and lateral lining. The principal practices to be installed are conservation cropping systems, irrigation water management, land leveling, structures for water control, and on-farm ditch lining.

Practices, amounts, and costs of land treatment are listed in Table 1. On-farm practices on irrigated cropland are not itemized, but total acres of treatment needed and costs are shown for "irrigated land."

Summary of Cost for Land Treatment Measures

The total installation cost for land treatment measures is estimated to be $930,970 of which $269,490 or 29% will be from P.L. 566 funds and $661,480 or 71% will be from other funds. The cost of the accelerated treatment program on the National Land Reserve, estimated to be $90,840 will be borne from P.L. 566 funds. The cost of the going program on the National Land Reserve, estimated to be $51,890, will be borne, subject to fund availability, from regular appropriations of the Bureau of Land Management. The cost of the accelerated land treatment program on the National Forest, estimated to be $112,520, will be borne from P.L. 566 funds. The cost of the going program on the National Forest, estimated to be $114,820, will be borne from regular Forest Service appropriations. Public Law 566 funds will bear $2,400 of the cost and the Utah State Department of Forestry and Fire Control $2,400 of the cost for fire control equipment. Public Law 566 funds will bear $9,200 of the cost and Utah State Department of Fish and Game funds will bear $9,200 of the cost for the land treatment measures to be installed on Utah State Department of Fish and Game land and State land leased by the Department. Other funds will bear the cost, estimated to be $436,720, for application of land treatment measures by private owners and operators on private and State lands. Only the cost of accelerated technical assistance for installation of accelerated land treatment measures on private and State lands will be borne from P.L. 566 funds.

Structural Measures

Structural measures to be installed will improve distribution system efficiencies and result in an increased water supply at the farm headgate. They will also supplement the land treatment program in reducing damages from sediment laden flood flows originating in the foothills and high mountains. See Table 1 and 2 for estimated cost distribution for all structural measures. See the project map for locations.

For Agricultural Water Management

Structural measures to be installed consist of improvements to irrigation company distribution systems and lateral ditches serving two or more water users. They include new diversion structures, concrete canal lining or pipelines on main and lateral canals, turnouts, headgates, measuring devices, and other appurtenances. Principal features of typical agricultural water management structural measures are shown on Figures 2 and 3. The total estimated installation cost for agricultural water management structural measures is $1,155,450. The amount to be borne by P.L. 566 funds is $618.990. Other funds will furnish $536,460.

Main Canal Lining: A total of 72,020 feet of main concrete canal lining will be installed within the systems of three irrigation companies. The Monroe and Annabella irrigation companies will line their entire main canals, 30,500 feet and 38,700 feet respectively. The Dry Creek Irrigation Company will line 2,800 feet of main canal below the proposed pipeline to complete the lining of their system.

These improvements will reduce excessive seepage and operational losses, operation and maintenance cost, and will permit better management of irrigation water supplies.

Design capacities range from 12 to 90 c.f.s. Bottom widths will range between 18 and 48 inches and depths between 24 and 54 inches. Side slopes will usually be 1:1.

Total estimated installation cost is $696,390. This includes the cost for preparing the foundations, excavation, headgates, measuring devices, drainage facilities, and other appurtenant structures.

Lateral Canal Lining: Approximately 68,500 feet of lateral concrete canal lining will be installed. The Monroe Irrigation Company will line 56,500 feet, 75%, of the laterals under their main canal. The Soil Conservation District and water users will line one lateral, 3,000 feet under the Brooklyn Canal and one lateral, 9,000 feet under the Monroe-South Bend Canal.

These measures will increase the conveyance and operational efficiencies, reduce operation and maintenance cost and permit maximum practical conservation and beneficial use of available water supplies.

These laterals, serving two or more water users, will have drainage capacities generally ranging from 6 to 15 c.f.s. Bottom widths will range from 6 to 18 inches. Depths will be less than 2.0 feet. Side slopes will usually be 1:1.

The total estimated installation cost for the lateral canal lining is $221,930.

Irrigation Pipeline: 31,300 feet of concrete or steel pipeline will be installed in the main distribution system of the Dry Creek Irrigation Company. This pipeline will replace a long, earthen ditch which winds across the fans and benchland and which has excessive seepage, erosion and maintenance problems.

This new pipeline will head in Dry Canyon and will convey streamflow from that drainage plus additional spring flow from Live Oak and Birch Springs to the company's service area. Open water accessible to livestock and game will be maintained at the Live Oak and Birch Springs.

Design capacities will be at least 6 c.f.s. for the main pipeline with smaller capacities for the branch lines to the springs.

The total estimated installation cost is $114,770 including cost of inlet structures, excavation, measuring devices, turnouts, and other necessary appurtenant structures.

Diversion Structures: Three concrete diversion structures will be installed in natural channels at the head of irrigation company distribution systems. The Monroe Irrigation Company and the Annabella Irrigation Company each will install a new diversion in the Sevier River at the head of their systems. A new diversion will also be installed at the mouth of Monroe Canyon to serve companies diverting water at this point. These new diversions will replace inadequate existing facilities. They will facilitate better management and distribution of water and reduce operation and maintenance costs.

Total estimated installation cost is $122,360.

For Flood Prevention

Structural works of improvement for flood prevention consist of two debris basins and streambank protection measures in Monroe Canyon. The debris basins are located low on the alluvial fan above Monroe City below the mouth of Sand, "H", and Bertlesen canyons. The streambank protection measures will be installed in Monroe Canyon within a 3-mile reach above the mouth of the canyon. See the project map for detailed location. The total estimated installation cost for these measures is $528,170. PL 566 funds will bear $512,920 and other funds will bear $15,250.

Debris Basins: These structures will consist of long, low earth fill dams at locations shown on Figure 1. Principal features of each structure are shown on preliminary plans Figures 4, 5, and 6. Capacity, size, areas, and other details are shown on Table 3.

The earth fills will have 3:1 side slopes upstream and 2:1 side slopes downstream with 14.0 feet top widths and settled heights less than 20.0 feet. They will be provided with reinforced concrete restricted flow principal spillways and with earth emergency spillways. Storage will be provided in each basin to accommodate the expected sediment accumulation over 50 years and to contain the runoff from a 100-year frequency short-duration summer rainstorm below the crest of the emergency spillway.

The principal spillways will consist of a reinforced concrete ported riser, concrete pipe outlet conduits, and concrete impact type stilling basins. The principal spillways will be designed to drain the basins at a rate non-damaging to downstream channels and improvements.

The emergency spillways are proportioned to pass the Emergency Spillway Hydrographs at a safe velocity for the sites. They will also pass the Freeboard Hydrographs with maximum water surface elevations below the settled height of the dam.

The Sand-"H" Canyon debris basin will have an embankment 3,000 feet in length, a maximum fill height of approximately 18 feet, and storage capacity for 80 acre feet of sediment and 54 acre feet of floodwater. Two principal spillways with restricted flow risers with combined outflow limited to 30 c.f.s. will be provided. The emergency spillway, having a total capacity of 1950 c.f.s. will be located at the north end of the

embankment. Training dikes will be provided at the south end of the dam and near "H" Canyon to direct runoff into the storage area. The total estimated installation cost for this structure is $268,250.

The Bertlesen Canyon debris basin will have an embankment 2,260 feet long, a maximum fill approximately 14.0 feet high and storage capacity for 36 acre feet of sediment and 17 acre feet of floodwater. The principal spillway will have a limited discharge capacity of 15 c.f.s. The emergency spillway with a total capacity of 1170 c.f.s. will be located at the south end of the dam. The total estimated installation cost is $110,250.

Monroe Creek Streambank Protection: Streambank protection to be installed on Monroe Creek includes 1,225 feet of grouted rock riprap and 590 feet of rubble masonry at critical points along the channel. These measures will reduce major damages at points of installation resulting from intense summer cloudburst storms and long duration spring snowmelt runoffs. Damages involved are

1. Erosion of the shoulder of the road leading to the Monrovian Park picnic area and the upper watershed.

2. Deposition of sediment around the upper power plant which supplies electric power to the city of Monroe.

3. Streambank erosion and loss of sections of the pipelines which supply culinary water to the city of Monroe and water for power production at the lower power plant.

The location of Monroe Canyon is shown on the project map. Locations and typical designs of the proposed protection work are shown on Figure 7.

The total estimated installation cost of this work is $149,670. The proposed works of protection are located partially on National Forest lands.

For Recreation

Three wildlife watering facilities for upland game birds will be installed in connection with stock watering stations along the Anderson Canyon pipeline. These facilities will increase the range and improve the survival of upland game bird broods and contribute to increased hunter success in the vicinity.

The estimated installation cost is $1,300. P.L. 566 funds will bear $750 and Utah State Department of Fish and Game funds will bear $550.

EXPLANATION OF INSTALLATION COST

Costs

Land Treatment Measures

Installation costs for land treatment measures on private and State lands are estimates of all costs associated with establishing the measures. They include the application cost to be borne by individual owners and operators, together with cost sharing assistance to be provided through the Agricultural Stabilization and Conservation program. The item of technical assistance includes the salaries of technicians who will assist the owners and operators in applying the measures.

Installation costs for the land treatment measures on Utah State Department of Fish and Game lands include the cost for establishing the treatment as well as associated personnel services and overhead costs.

Installation costs for treatment measures on Federal land includes the cost for establishing the treatment, associated technical services including soil surveys to determine suitability and exact location of the treatment, and overhead supervisory costs. Operation and maintenance costs reflect those needed to maintain the critical area treatment during the project installation period.

Estimates of quantities and costs for all land treatment measures are based upon surveys of watershed lands and on costs incurred for similar treatment in other projects. Application costs for each measure includes a contingency allowance to insure its establishment. All costs reflect current and local prices for the operations and services and materials involved in each practice. The estimated technical assistance costs for all measures is based upon an analysis of the costs for planning and applying similar measures.

Structural Measures

The installation costs shown in Tables 1 and 2 included all costs to be incurred in installing the structural measures. Installation costs includes construction, installation services, land rights, and contract administration.

Construction costs shown for each structural measure represents a sound estimate for the cost of each contract for installation of each structural measure. Construction costs consist of the engineer's estimated cost for each structural measure increased by 15% for contingencies. The engineer's estimated cost is a summation of the products of unit costs and the construction quantities included in the bid item schedules for each structural measure.

Installation services cost, based upon 25% of the contract cost, includes all personnel services cost associated with the survey, design, preparation of contracts, and supervision of construction. Engineering services make

up 68% of installation services cost and other personnel services account for 32%. Additional installation services costs are included for the debris basins for foundation investigations and materials testing prior to final design.

Land rights costs consist of the fair value of the rights and legal and personnel services associated with their acquisition. Land rights costs for each structural measure represents local experience in their acquisition for similar installations in this and similar watersheds.

Contract administration costs include all personnel services, overhead, and cash costs associated with administration of contracts. Contract administration costs shown for each structural measure, based upon the number of contracts and the cost of administering each, represents the experience of local sponsoring organizations in other watersheds where similar measures have been installed.

No multiple purpose structural measures are included in this plan. Costs of the single purpose measures are allocated to the purpose served.

Cost Sharing

Project costs are estimated to be $2,615,890. PL 566 funds will provide $1,402,150 or 54 per cent, and other funds will provide $1,213,740 or 46 per cent of this cost. Assignments of cost of PL 566 funds are in accordance with the requirements of PL 566 as amended and the policy statement of the Secretary of Agriculture.

The following specific costs will be borne by PL 566 funds:

1. Cost of technical assistance for accelerated land treatment on non-Federal land, $54,530.

2. Cost for accelerated application of land treatment measures on Federal land, $192,205.

3. Operation and maintenance costs during project installation for accelerated land treatment measures on Federal land, $11,155.

4. Federal share of the cost for fire suppression equipment on non-Federal land, 50%, estimated to be $2,400. Sharing of cost is based upon rates currently authorized under other programs.

5. Federal share of the installation cost for the land stabilization measures on Utah State Department of Fish and Game land and State land leased by the Department, 50%, estimated to be $9,200. Sharing of cost is based upon rates currently authorized under other programs.

6. Federal share of the construction cost for wildlife watering facilities, 50%, estimated to be $500.

7. Construction cost of structural measures for flood prevention, $405,570.

8. Federal share of the construction cost for agricultural water management measures, 50%, estimated to be $412,660.

9. Costs of installation services for structural measures, $313,930.

The following specific costs will be borne from other funds:

1. Cost for application of land treatment measures to be installed by private owners and operators on private and State land, estimated to be $436,720. Cost sharing assistance available under other programs at the time of installation will be utilized.

2. Cost of technical assistance for going program for land treatment measures on non-Federal land $46,450.

3. Installation cost for land treatment measures to be installed on Federal land under going program, $166,710.

4. Non-Federal share of the cost for fire suppression equipment on non-Federal land, 50%, estimated to be $2,400.

5. Non-Federal share of the installation cost of the land stabilization measures to be installed on Utah State Department of Fish and Game land and State land leased by the Department, 50%, estimated to be $9,200.

6. Non-Federal share of the construction cost for wildlife watering facilities, 50%, estimated to be $500.

7. Non-Federal share of the construction cost for Agricultural Water Management measures, 50%, estimated to be $412,660.

8. Land rights cost, $90,780.

9. Cost for administration of contracts for project installations, $48,320.

Schedule for Expenditure of Funds

Year of Project	PL 566	Other	Total
First	$ 176,580	$ 134,380	$ 310,960
Second	688,460	262,145	950,605
Third	126,090	171,290	297,380
Fourth	175,850	178,790	354,640
Fifth	86,600	79,065	165,665
Sixth	62,825	103,425	166,250
Seventh	35,005	81,025	116,030
Eighth	39,260	89,240	128,260
Ninth	6,220	57,190	63,410
Tenth	5,500	57,190	62,690
Total	$1,402,150	$1,213,740	$2,615,890

EFFECTS OF WORKS OF IMPROVEMENT

The structural and land treatment measures included in this plan may be grouped into three general classes on the basis of the primary effects and benefits each group is designed to accomplish. They are:

1. Land treatment and structural measures in the upper watershed and the foothill area which will reduce flood runoff, retard sediment movement, curb erosion, increase forage production, and protect utilities and urban property from damaging floods.

2. On-farm structural and land treatment measures whose primary effects will center around the conservation of irrigation water and the maintenance and improvement of the productivity of irrigated cropland.

3. Agricultural water management structural measures which will control and stabilize canal flow and reduce seepage losses.

Flood and Sediment Damage Reductions

Taken together, the land treatment measures scheduled for upper watershed and foothill areas are an integrated approach toward alleviating flood runoff and sediment production from critical areas and in retarding the development of widespread erosion on the steep mountain front. The trenching, seeding, and other erosion control measures on critical areas will revegetate and

stabilize spots which contribute in varying degrees to damaging flood runoff in the valley and will also prevent the encroachment of active gullies into adjacent lands. Protection from grazing by fencing will also permit the grazing of land surrounding the treated spots. This will allow the development and grazing use of high forage producing areas on adjacent lands and the redistribution of the grazing load in accordance with the needs and capabilities of watershed lands.

The small size of the intensively treated critical areas in relation to the acreage of the drainages in which they are located and the areas covered by normal storm patterns holds flood runoff reductions in major downstream damage areas from 3% to 6%. Despite these small downstream effects, the critical area treatment occupies a key position in the interdependent function of over-all watershed treatment.

Brush control and seeding on selected areas in the lower foothills will arrest widespread erosion on the steep mountain front and will also provide much needed winter range for game and livestock. The grazing of domestic livestock is an important aspect of the management plan for treated units since it will prevent the dominance of the grass species over the browse plants relished by deer. Present erosion rates will be arrested and the grazing load of big game and livestock can be maintained or increased with the installation of project measures.

The structural measures for flood control in Sand, "H", and Bertlesen canyons will give protection to homes, streets, ditches, canals, utilities, and farmlands in and adjacent to Monroe. The Sand-"H" and Bertlesen canyons debris basins are designed to hold a 50-year accumulation of sediment and will contain a 100-year frequency flood runoff volume. Present annual damages assigned to Sand-"H" and Bertlesen canyons will be reduced 97% when the proposed structures are installed. The remaining residual damages will result from sediment carried through the principal spillways. The two structures jointly give direct and complete flood protection to about 1,320 acres of farmlands, to fixed improvements, and urban property in Monroe City at the toe of Sand and Bertlesen fans. By protecting the Monroe City ditch and the old Annabella Extension Canal and a segment of the Monroe Irrigation Company canal, the structures insure continued delivery of water to a total of 340 lots in Monroe City and 1,320 acres of farmlands. The use of this water in yards and gardens in Monroe gives it high value since it substitutes for water which would ordinarily be derived from the limited culinary supply.

The streambank protection in lower Monroe Canyon will give protection to pipelines conveying water to the power plants and the city water supply and to the road which is the only improved access route to recreation and grazing areas in the upper watershed. The road also connects with U. S. 89 and State Highway 24. In protecting the pipelines, it will also stabilize the production of electric power in Monroe City's lower power plant. It is estimated that damages to utilities and facilities in the lower canyon will be reduced by 85%. The treatment affords complete protection from large floods of a 50-year frequency occurrence and a substantial degree of protection from floods of 100-year frequency occurrence.

Effects of Agricultural Water Management Measures

On-farm land treatment will be applied more or less uniformly over the entire acreage of irrigated land. Estimated improvements in farm irrigation efficiencies are projected as average increases over the 12,200 acres of irrigated lands. The increase in farm headgate supply stemming from system improvements will directly affect 5,950 acres. There will be a shift of about 11% in the project acreage toward more corn, beets, potatoes, and small grain. The aggregate effect of the on-farm measures will be to improve the use of soil and water resources and induce a more efficient farm management program.

On-farm measures scheduled for installation under this plan will improve irrigation efficiencies and promote the application of improved farm technology and management. The measures are expected to move farm efficiencies from a prevailing range of 45% to 50% to about the 55% level. The improvement in irrigation efficiency will enable the full irrigation of some crop acreages now only partially irrigated. This is, in effect, equivalent to an increase in supply at the farm headgate of about 4%. It will also augment the value of additional headgate supply which will come from a reduction in seepage losses in canals and laterals.

The irrigation system improvements will produce a 13% increase in gross water supply at the farm headgate. They will also facilitate management of irrigation water and reduce operation and maintenance costs. The installation of accurate measuring and control devices in canals and at the heads of laterals will permit a more equitable distribution of water among users and will provide a sound basis for improved water management throughout the system and on farms.

Net farm income will have increased by approximately 13% after the farmer's share of the costs of on-farm measures and system improvements have been deducted.

Wildlife Effects

The improvement of the deer winter range as a result of the land treatment to be installed is important. The direct improvement in amount and quality of forage on deer winter range produced by the treatment will be supplemented by a widespread vegetal improvement over the steep mountain front area used by deer in spring and fall. Direct benefits to big game from the proposed range rehabilitation measures would be:

1. An increased forage production in future years, and

2. An improved condition of the deer herd in general.

In addition to improvement in native vegetation, the seeded areas will also provide improved habitat conditions for upland game birds.

Recreation Effects

The installation of the three watering facilities for upland game birds will establish watering centers which will benefit all wildlife species. The type facility to be installed will be especially effective in extending the range of upland birds and raising the survival ratio of bird broods.

Downstream Effects of Agricultural Water Management Measures

The Sevier-Sigurd groundwater basin is located within the Sevier River valley trench with its southern limit near the Clear Creek-Sevier River confluence and its northern limit near the Rockyford Reservoir. The alluvial fill of the Sevier Valley is composed largely of coarse, angular sands and gravels with clay lenses interspersed throughout. The lower and central portion of the alluvial fill is overlain by a wedge-shaped clay layer from the lower limit to a point near the town of Central. This portion of the reservoir is under hydrostatic pressure due to the confining clay top stratum. The permeable materials of the recharge area and the artesian area are all connected hydraulically. Maximum groundwater levels occur in the artesian area during the winter and early spring. The storage capacity of this groundwater basin is estimated to be 800,000 acre feet with a storage per foot of depth between 5,000 and 6,000 acre feet. It is also estimated that 30,000 acre feet from this reservoir is consumed by non-beneficial vegetation and evaporation annually.

Under present conditions, water lost through inefficiencies in distribution systems and on farms within the Monroe-Annabella Watershed contributes to the groundwater basin and growth of non-beneficial vegetation. This water contributes directly to the flow of the Sevier River downstream only when the groundwater reservoir is near capacity and the hydraulic profile surfaces upstream from the clay top stratum and during high spring flows. Water not consumed beneficially in the wet meadow area percolates slowly to the groundwater table and runs off into depressions and the Sevier River where it is consumed by non-beneficial vegetation and evaporated.

The proposed improvements will deliver water to the farm headgate with greater efficiency. This will reduce the water consumed by non-beneficial vegetation along the canals and laterals and reduce the extent of wet areas on and along fields. The increased headgate supply will increase the amount of water returning to the groundwater basin through deep percolation from the fields. The increased headgate supply combined with improved application efficiency on farms will enable changes in cropping patterns to be made which will result in lower consumptive use requirements.

The combined effect of improved distribution efficiency, improved on-farm efficiency, and changes in cropping pattern will enable stored water to be held for later release when it will benefit crop production more and possibly contribute to hydrostatic pressure in the artesian portion of the groundwater basin later in the following irrigation season. The reduction in distribution losses, improvements in on-farm efficiency, and changes in cropping pattern will also reduce the diversion requirements, especially during April-May and September-October.

No measurable effect in hydrostatic pressure is expected in the artesian area of the groundwater basin as a result of the project. No measurable changes are expected in groundwater levels over the basin. It is expected

that reductions in the use of water by non-beneficial vegetation along the canals, laterals, and the river, within the wet meadows and the wet areas throughout the watershed, will more than offset any additional water consumed by increased crop production.

No measurable changes are expected to occur in streamflow as a result of the project since streamflow is dependent upon natural yield and stored water from upstream sources, from artesian flow, and drainage from the artesian portion of the basin.

PROJECT BENEFITS

Flood Prevention Benefits

Annual benefits from the structural measures for flood prevention total $28,245, including secondary benefits. Primary benefits are made up entirely of flood damage reduction benefits.

Annual benefits of $14,855 will accrue from the Sand-"H" debris basin located directly east of Monroe City. Damage to streets, water facilities, urban property, and to crop and pasture land will be largely eliminated. Over 45% of the benefits assigned to this structure are from reduction in damages to crops, farmlands, and irrigation facilities. Reduction in damage to urban property, roads, and streets, and to power and water facilities make up about 50% of all reductions. Reductions in indirect damages account for 5% of the total.

The Bertlesen Canyon debris basin will give damage reduction benefits of $5,290 annually. Of this, $3,845, comprising 70% of the total, is made up of damage reductions to agricultural water facilities, crops, and farmlands. Benefits to urban property of $1,210 annually amounts to an additional 22% and reflects damage reductions to homes, streets, and lots in the southeast part of Monroe City. Remaining benefits of 8% are reductions in indirect damages.

The streambank protection to be installed along lower Monroe Creek will produce benefits of $8,100 per year. This represents an 85% reduction in damages to the main canyon road, the city culinary pipeline, and to the waterline which conveys water to the lower municipal power plant. Residual damages of about $1,325 per year to crop and pasture lands which derive their irrigation supply from Monroe Creek will continue.

Land treatment in the foothills and at high elevations in the watershed, particularly seeding and brush control, will reduce projected land deterioration from gully erosion by 50%, giving annual benefits of $1,085. Land treatment on critical areas will produce an additional $1,210 annually in flood reduction benefits.

Agricultural Water Management Benefits

On-farm land treatment measures will be installed over the 12,200 acres of irrigated land. The physical effects of these measures have been detailed in preceding paragraphs.

Structural measures for agricultural water management will produce annual benefits of $95,200.

Lateral ditch lining on 16 laterals will reduce seepage losses and increase farm headgate supplies on about 3,250 acres of land. This will facilitate the irrigation of these lands and produce net annual benefits of $24,255.

Lining of main canals supplying 5,670 acres will further reduce conveyance losses, provide a more stable irrigation supply, and will increase average net farm income by $70,945 per year. Additional benefits from reduced operation and maintenance costs for canals will accrue. The new diversion structures will insure efficient delivery of available supply and will relieve the irrigation companies of costly maintenance at these points. These benefits have not been evaluated in monetary terms.

Recreation Benefits

The improvement of wildlife habitat through the installation of wildlife watering facilities will generate increased hunter use of a large area in the southeast part of the watershed. Benefits will average $300 annually.

Secondary Benefits

Secondary benefits from a national standpoint were not evaluated. Local secondary benefits evaluated and included in total project benefits are generated by primary farm production benefits. The items entering the market at the farm level are livestock and livestock products. The prices received for such products together with the production cost were taken at the local farm level. Secondary benefits stemming directly from the increased farm production made possible by flood prevention measures were calculated as 10% of the direct primary production benefits and are considered to be a conservative estimate of the profits which will accrue to local merchants through increased purchases of consumer items by farm families. Additional secondary benefits will be induced in the community through increased expenditures for production items such as fertilizer, seed, feed concentrates, labor, equipment, livestock, and taxes. Such additional benefits accruing locally were calculated as 10% of the cost of increased expenses for items used in the production of livestock products.

Secondary benefits of $6,885 per year make up 24% of total benefits assigned to the structural measures for flood prevention on Sand-"H" and Bertlesen Washes and in Monroe Canyon. They originate through the protection afforded the irrigation and municipal water supply and to irrigated croplands.

The project area economy is almost entirely dependent upon agricultural production. Labor resources exceed the demand both within the project and surrounding area.

Any increase in agricultural production has a significant impact on the total economy by providing additional labor and service opportunities.

COMPARISON OF BENEFITS AND COSTS

Primary benefits from all structural measures are $116,860 annually as compared to annual costs of $20,745. The over-all benefit-cost ratio for these measures is 1.7 to 1.

Information relating to the justification of individual and groups of measures are outlined in Table 6.

PROJECT INSTALLATION

This plan will be carried out as a joint undertaking of private, local, State, and Federal interests.

Non-Federal interests include individual farmers and ranchers; Sevier County and Piute County Soil Conservation Districts, Sevier County irrigation companies, Monroe City, Utah State Department of Fish and Game; Utah State Department of Forestry and Fire Control, Utah State Land Board; Utah Water and Power Board, and the Utah State University Extension Service.

Participating Federal agencies interested include the Soil Conservation Service, Forest Service, Bureau of Land Managment, Farmers Home Administration, and the State and County Agricultural Stabilization and Conservation Committees.

Sponsoring organizations will acquire necessary lands, easements, and rights-of-way, execute agreements with owners of private lands for installation of the land treatment measures, provide the non-Federal share of the installation cost of structural measures, and cooperate with other local, State, and Federal agencies concerned with the project. Local sponsoring organizations will contract for the construction of the structural measures in the work plan.

Sponsors will secure the necessary lands, easements, and rights-of-way by negotiation or will use their right of eminent domain. Necessary lands, easements, and rights-of-way will be secured for one or more construction units before Federal financial assistance is made available for construction of any structural measures in the designated construction unit.

Monroe City, incorporated under State laws of Utah, has powers of taxation, eminent domain, can accept contributions, levy assessments, hold elections for loan or bond authorization, make annual levies to retire these obligations, and enter into special-use agreements with land administering agencies for construction and maintenance of improvements.

The irrigation companies, legally organized under State laws, have powers of eminent domain, can accept contributions, and levy assessments against their stock for repayment of obligations and operation and maintenance costs.

The Sevier County Soil Conservation District, a body politic and corporate, is empowered to enter into agreements and contracts, to sue and be sued, carry out soil and water conservation operations, and apply soil conservation treatment within the boundaries of the district.

The Federal land administering agencies have concurred in the provisions of the work plan.

Responsibilities for Installation

In order to coordinate the installation of the accelerated land treatment measures and structural measures provided for in the plan and the going conservation programs within the watershed, close co-operation and specific responsibilities are required of private interests, the sponsors, local, State, and Federal agencies assisting in this project.

Sevier County Soil Conservation District will:

1. Provide local leadership and direction which will continue the going program of the District at the rate which existed prior to development of this work plan.

2. Provide local leadership to insure the scheduled installation of the accelerated land treatment measures on private and State lands.

3. Survey, acquire, and record all necessary lands, easements, and rights-of-way for groups of water users participating in the lateral canal lining program under the Monroe-South Bend and Brooklyn service areas and the diversion dam on Monroe Creek.

4. Act as local contracting organization for construction of the measures in item 3 and furnish the non-Federal share of the construction cost.

Monroe City will:

1. Survey, acquire, and record all necessary lands, easements, and rights-of-way for the debris basins and obtain Forest Service special-use permits, and Federal Power Commission approval to construct streambank protection structures necessary for the protection of existing improvements that are under special-use permits from the Forest Service or licensed by the Federal Power Commission.

2. Act as local contracting organization for the construction of the debris basins and the streambank protection.

Monroe Irrigation Company will:

1. Survey, acquire, and record all necessary lands, easements, and rights-of-way for their diversion dam, main canal, and certain laterals serving two or more users under their system.

2. Act as local contracting organization for the construction of these measures and furnish the non-Federal share of the construction cost.

3. Provide leadership, encourage and assist water users under their system to attain more efficient use of available water supplies through application of the scheduled land treatment measures and better management practices.

Annabella Irrigation Company will:

1. Survey, acquire, and record all needed lands, easements, and rights-of-way for their diversion dam and main canal.

2. Act as local contracting organization for the construction of these measures and furnish the non-Federal share of the construction cost.

3. Provide leadership, encourage and assist water users under their system to attain more efficient use of available water supplies through application of the scheduled land treatment measures and better water management practices.

Dry Creek Irrigation Company will:

1. Survey, acquire, and record all necessary lands, easements, and rights-of-way for construction of their pipeline and canal.

2. Act as local contracting organization for construction of these measures and furnish the non-Federal share of the construction cost.

3. Provide leadership, encourage and assist water users under their system to attain more efficient use of available water supplies through application of the scheduled land treatment measures and better water management practices.

Utah State Department of Fish and Game will:

1. Act as local contracting organization and furnish the non-Federal share of the installation cost for clearing and seeding of 930 acres of rangeland owned by the Department or leased from the State. Co-operate with land administering agencies and local interests in installing treatment on Federal land.

2. Co-operate with local, State, and Federal agencies in making exchange use agreements, range and vegetation surveys, utilization checks, or other studies involving forage utilization; manage fish and game resources of the project area within the scope of the Fish and Game Code of Utah, and continue big game harvesting programs which will maintain big game herds in balance with game forage production.

3. Provide the non-Federal share of the installation cost for upland game bird watering facilities and install the treatment.

4. Develop upland game habitat on private lands under the regular department program in co-operation with the program of the Sevier County Soil Conservation District.

5. Maintain close liaison with sponsors and other agencies and groups participating in the project and assist in appropriate revisions of the work plan.

The Soil Conservation Service will:

1. Furnish necessary technical assistance through the Sevier County Soil Conservation District to private land owners for installation of land treatment measures on non-Federal lands.

2. Provide funds for the Federal share for installation of the land treatment measures on Utah State Department of Fish and Game lands in accordance with cost sharing and time schedules set forth herein.

3. Furnish the necessary installation services for engineering surveys, designs, construction plans and specifications, and construction supervision for installation of the structural measures.

4. Provide construction funds for the project in accordance with the cost sharing and time schedules set forth herein or as revised by mutual agreement and in accordance with national priorities.

5. Maintain liaison with sponsors and State and Federal agencies participating in the project to the end that unified effort and coordinated action will produce the most effective results. Consult with and assist the sponsoring organizations, local, State, and Federal agencies, in making desirable revisions or amendments of this plan if and when circumstances dictate.

The U. S. Forest Service will:

1. Install the land treatment measures on National Forest land in accordance with the program outlined in Table #1.

2. Adjust grazing and other uses on National Forest land to facilitate the installation of the planned works of improvement. These measures have been scheduled for installation in a sequence which will necessitate the least practical inconvenience and unfavorable economic impact on the grazers.

3. Coordinate the treatment, use, and management of National Forest lands contiguous to treatment areas on the National Land Reserve and Utah State Department of Fish and Game lands to effect minimum treatment cost and optimum utilization by big game and livestock.

4. Furnish technical assistance for planning and application of practices under its departmental responsibility for technical adequacy for woodland planning. This will be done in co-operation with the Utah State Department of Forestry and Fire Control.

5. Authorize access roads, borrow areas, and other land occupancy by special-use permits and administer the use in accordance with provisions of the permit.

The Bureau of Land Management will:

1. Install the land treatment measures on the National Land Reserve in accordance with the program outlined in Table #1.

2. Adjust grazing and other uses on National Land Reserve to facilitate the installation of the planned works of improvement. These measures have been scheduled for installation in a sequence which will necessitate the least practical inconvenience and unfavorable impact on the grazers.

3. Coordinate the treatment, use, and management of National Land Reserve contiguous to treatment areas on the National Forest and Utah State Department of Fish and Game lands to effect the least practical treatment cost and optimum utilization by big game and livestock.

4. Determine the suitable time for renewal of grazing use of the treatment areas on the National Land Reserve.

The following State agencies, by agreement with the sponsors, will participate as shown.

Utah State Department of Forestry and Fire Control will:

1. Furnish the non-Federal share of the cost for fire control equipment and install and supervise the use and maintenance of this equipment in co-operation with Sevier and Piute counties.

2. Arrange for adequate fire pre-suppression and suppression plans.

Utah State Land Board will:

1. Participate with permittees and the Sevier and Piute County Soil Conservation Districts in the proper management and grazing of State land.

Utah Water and Power Board will:

1. To the extent permitted by State law, availability of funds, and Utah Water and Power Board regulations, make financial assistance available to the sponsors or water users.

The Utah Co-operative Extension Service will:

1. Give high priority in carrying out an effective education and information program in co-operation with the sponsors of this project.

The Agricultural Stabilization and Conservation Committees, State and County will:

1. Give high priority to scheduling ACP funds to expedite the land treatment on private and State lands.

Schedules for Installation

Going conservation programs of the Sevier and Piute County Soil Conservation Districts and Federal and State agencies co-operating in this project are an integral part of this plan and will continue at least at the same rate that existed prior to the development of the watershed work plan.

The installation of accelerated land treatment measures which have a measurable effect in reducing water losses and increasing on-farm irrigation efficiencies will begin in the first year of the project and be completed during a 10-year installation period. The systematic installation of the on-farm measures concurrently with the agricultural water management structural measures is essential to the successful application of the provisions of this plan. Accordingly, the scheduled assistance for the installation of structural measures for agricultural water management will depend on substantial year-by-year progress in the installation of the on-farm measures.

The installation of accelerated land treatment measures which have measurable effects in flood prevention will begin during the first year of the project and be completed during a 10-year project period. Treatment and adjustment in use will be made in accordance with the schedule for the installation of the structural measures. The effect on normal farm and ranch operation was considered in developing the schedules for installation and will be considered in any adjustments in scheduling during the installation period.

The installation of the structural program for flood prevention is scheduled concurrently with or after the installation of required land treatment above the structures. The installation of the structural measures for agricultural water management is scheduled concurrently with the installation of the on-farm land treatment measures.

The proposed installation schedule is as follows:

Fishlake-National Forest (F.S.)

1st year

Install treatment--Thompson Creek, 900 acres: chain pinyon-juniper, seed browse and grass, construct 2.5 miles of fence; Wingate-Order Canyons, 40 acres: chain juniper, seed browse and grass; Sand Canyon, 130 acres: chain juniper and contour trench.

2nd year

Install treatment--Doxford Creek, 85 acres: contour trench, seed grass and browse, construct 2.8 miles of pole fence; Circle Cottonwood, 800 acres: spray sagebrush and rebuild 2 miles of management fence; Little Monroe Creek, 300 acres: spray sagebrush, maintain Sand Canyon treatment.

3rd year

Install treatment--Nelson Canyon, 230 acres: plow and seed, construct 2.5 miles of pole fence; Nelson Canyon, 13 acres: contour trench and seed; South Dry Canyon, 50 acres: contour trench and seed, construct 1.1 miles of fence. Maintain previously installed treatment.

4th year

Install treatment--First Left Hand Fork of Monroe Creek, 85 acres: contour trench and seed, construct 2 miles of pole fence; Shingle Creek: gully stabilization, 1.5 miles, roadside erosion control, 0.75 miles; Third Left Hand Fork of Monroe Creek, 15 acres: contour trench and seed, road and trail erosion control, 2.25 miles; Maple Canyon, 85 acres: contour trench and stabilize gullies. Maintain previously installed treatment.

5th year

Install treatment--Live Oak Canyon, 50 acres: contour trench and seed, construct 2 miles fence and 0.5 miles of roadside erosion control; Corner Spring Canyon, 50 acres: contour trench and seed; First West Serviceberry, 45 acres: contour trench and seed; Serviceberry Creek: road and trail erosion control, 2.5 miles; maintain previously installed treatment.

6th year

Install treatment--Dry Canyon, 500 acres: spray sagebrush; Dry Canyon, 125 acres: contour trench and seed, construct 3.1 miles of pole fence and complete 0.5 miles of trail maintenance. Dry Canyon slip: construct 0.3 miles of fence and stabilize slip; Barney's Lake-Dry Canyon, 85 acres: contour trench and seed and construct 1.2 miles of pole fence. Maintain previously installed treatment.

National Land Reserve (BLM)

1st year

Eradicate pinyon-juniper, seed and fence Maple Creek and Thompson Basin treatment areas, 710 and 260 acres.

2nd year

Eradicate pinyon-juniper, seed and fence White Hills and Poverty Flat treatment areas, 1,000 and 720 acres.

3rd year

Maintain previously installed treatment. Install co-op allotment fence.

4th year

Maintain previously installed treatment. Eradicate pinyon-juniper, seed and fence Antelope Range treatment area, 720 acres.

5th year
Construct Joseph and Long Valley division fence. Maintain previously installed treatment.

6th year
Eradicate brush, seed, and fence Poverty Flat sagebrush treatment area, 1,200 acres. Maintain previously installed treatment.

8th year
Install Anderson Canyon pipeline, 3 miles; maintain previously installed treatment.

9th year
Maintain previously installed treatment.

Utah State Department of Forestry and Fire Control

1st year
Install radio equipped, 3/4 ton, 4 x 4 brush type pumper truck.

Utah State Department of Fish and Game

2nd and 4th years
Clear pinyon-juniper and seed 930 acres coordinated with Bureau of Land Management treatment in the White Hills and antelope range.

8th year
Install upland game bird watering facilities in Anderson Canyon pipeline in co-operation with the Bureau of Land Management.

Soil Conservation District

1st year
Obtain land, easements, and rights-of-way for 1/3 of lateral lining, design lining, and prepare contracts.

2nd year
Construct 1/3 of the lateral lining. Obtain land, easements, and rights-of-way for an additional 1/3 of the lateral lining. Design lining and prepare contracts.

3rd year
Construct 1/3 of the lining. Obtain land, easements, and rights-of-way for the last 1/3 of the lining. Design lining and prepare contract.

4th year
Construct last 1/3 of the lateral lining. Obtain land, easements, and rights-of-way for the diversion structures on Monroe Creek, design, prepare contract, and construct.

Annabella Irrigation Company

1st year
Obtain land, easements, and rights-of-way for the diversion dam. Design and prepare contract.

2nd year
Construct the diversion dam. Obtain land, easements, and rights-of-way for the canal lining and prepare designs.

3rd, 4th, and 5th years
Construct 1/3 of the canal lining each year.

Dry Creek Irrigation Company

1st year
Obtain land, easements, and rights-of-way for the pipelines and canal lining. Prepare designs and contracts.

2nd year
Construct the pipelines and canal lining.

Monroe Irrigation Company

1st year
Obtain land, easements, and rights-of-way for the diversion dam and main lining. Design and prepare contracts.

2nd year
Construct the diversion dam and 1/3 of the main lining.

3rd and 4th years
Construct 1/3 of main canal lining each year.

5th year
Obtain land, easements, and rights-of-way for lateral lining. Design and prepare contracts.

6th, 7th, and 8th years
Construct 1/3 of lateral lining each year.

Monroe City

1st year
Obtain land, easements, rights-of-way, and special-use permits for the debris basins and streambank protection works, complete foundation investigations for the debris basins, prepare designs and contracts.

2nd year
Install debris basins and streambank protection works.

FINANCING PROJECT INSTALLATION

Sponsoring local organizations are legally organized under State laws and are empowered and qualified to install, operate, and maintain project measures included herein. They have reviewed the program costs outlined in Tables 1 and 2 and have participated in cost-sharing decisions. They have given the Service adequate assurance that their share of the installation cost allocated to them will be available at the time and in the amounts required.

None of the sponsors has a history of delinquency.

Local sponsors who intend to use loan provisions of the Act to help finance their share of the installation cost for measures which they sponsor have filed a letter of intent with the State Director of the Farmers Home Administration outlining their need for credit. Negotiotions and investigations are underway to insure that needed credit will be available at the time and in the amounts required.

Installation costs allocated to PL 566 funds will be furnished from funds appropriated under the authority of PL 566, 83 Congress, 68 Stat. 666 as amended. This work plan does not constitute a financial document for obligation of Federal funds, and financial or other assistance to be furnished by the Soil Conservation Service is contingent upon the appropriation of funds for this purpose.

Cost sharing and other assistance currently available through going conservation programs of the Sevier and Piute County Soil Conservation Districts, the Agricultural Conservation Program, and other Federal and State agencies co-operating in this project are an integral part of this plan and will be expected to be available at least in the amounts and rates that existed prior to the development of this work plan.

The installation cost for accelerated land treatment measures on private and State land will be borne by individual land owners, operators, and leasees utilizing accelerated cost-sharing assistance available through the Agricultural Conservation Program.

Land Treatment Measures

The County and State Agricultural Conservation Committees have reviewed the accelerated land treatment needs for private and State lands and believe they can provide accelerated cost-sharing funds for installation of these measures.

Technical assistance will be provided through the going program at the current rate for installation of the going program on private and State lands. PL 566 funds will be provided for needed accelerated technical assistance for installation of the accelerated land treatment program on private and State lands.

Accelerated land treatment measures on Federal land will be financed jointly from PL 566 funds and from regular funds of the land administering agencies. The going programs for Federal lands will be financed from regular appropriations of the land administering agencies.

The Utah State Department of Fish and Game will finance their share of the installation cost for land treatment measures from regular sources of revenue of the Department.

The Utah State Department of Forestry and Fire Control will finance their share of the installation cost for the fire control equipment from regular sources of revenue of the Department.

Structural Measures

Flood Prevention Measures

Monroe City will use the loan provisions of the Act to help finance their share of the installation cost for the structural measures for flood prevention. It is expected that 25% of the lands, easements, and rights-of-ways will be donated. Contracts will be administered largely by officers and regular employees of the city. They will request a loan in the amount of $4,000.

Repayment of the loan will be from funds raised through regular taxing authority of the city.

Agricultural Water Management

The irrigation companies will use the loan provision of the Act to help finance their share of the installation cost for system improvement measures. It is expected that approximately 80% of the lands, easements, and rights-of-ways will be donated. Contracts will be administered largely by regular officials of the respective irrigation companies. Anticipated loan requirements follow:

Annabella Irrigation Company	$140,565
Monroe Irrigation Company	$248,695
Dry Creek Irrigation Company	$ 46,285

Repayment of loans will be provided through assessment of stock and through contract with users of laterals.

The Sevier County Soil Conservation District will use the loan provisions of the Act to help finance the local share of the installation cost for certain laterals and the Monroe Creek diversion. It is expected that land, easements, and rights-of-way will be donated.

The District will request a loan in the amount of $25,175. The District will enter into contract with affected users for repayment of the loan.

Recreational Development

The Utah State Department of Fish and Game will finance their share of the installation cost for the wildlife watering facilities from regular sources of revenue of the Department.

PROVISIONS FOR OPERATION AND MAINTENANCE

Land Treatment Measures

Land treatment measures installed on Federally owned land will be operated and maintained from regular funds of the Land Administering Agency after the period of installation. Operation and maintenance during the period of installation will be from project funds as shown on Table 1.

Land stabilization measures to be installed on Utah State Department of Fish and Game lands and State land leased by the Department will be operated and maintained by the Utah State Department of Fish and Game from regular funds of the Department.

Fire suppression equipment to be obtained as a part of this project will be stationed in the project area. It will be operated and maintained under agreements between Sevier and Piute Counties, Monroe City, and the State Department of Forestry and Fire Control, which will specify the areas of use and fix the cost sharing for operation and maintenance. Annual operation and maintenance costs will be from regular funds of the Department.

Structural Measures

Inspections of all works of improvement will be made at least annually and after all floods by representatives of the Sevier County Soil Conservation District, Soil Conservation Service, and the sponsoring organization responsible for operation and maintenance. The responsible organization will perform the maintenance work as needed.

Specific operation and maintenance agreements between the sponsoring local organization and the Service, covering all phases of operation and maintenance will be executed prior to making funds available to local organizations for the installation of works of improvement.

Flood Prevention Measures

Monroe City will be responsible for the operation and maintenance of the Sand-"H" Canyon and the Bertlesen Canyon debris basins and the streambank protection measures in Monroe Canyon. Total annual operation and maintenance costs are estimated to be $700.

Agricultural Water Management Measures

The respective irrigation companies will be responsible for the operation and maintenance of canal lining, pipelines, and diversion dams to be installed within their systems. The Sevier County Soil Conservation District will be responsible for the operation and maintenance of the diversion dam on Monroe Creek and certain laterals. Respective groups of farmers and ranchers will operate and maintain these improvements in accordance with supplemental operation and maintenance agreements with the Soil Conservation District with approval of the Soil Conservation Service.

These measures will replace or renew existing facilities and will result in a net decrease in operation and maintenance costs. Remaining operation and maintenance costs are estimated to be $2,580 annually.

Recreational Measures

The Utah State Department of Fish and Game will be responsible for operation and maintenance of the wildlife watering facilities. Annual operation and maintenance costs are estimated to be $20.

TABLE 1 - ESTIMATED PROJECT INSTALLATION COSTS

Monroe-Annabella Watershed, State of Utah

Installation Cost Item	Unit	Number			Estimated Cost (Dollars) 1/						
					PL 566 Funds			Other			
		Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed. Land	Total	Federal Land	Non-Fed Land	Total	TOTAL
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Land Treatment											
Soil Conservation Service											
Conservation Treatment											
Irrigated Land	Acres		12,200	12,200					410,900	410,900	410,900
Range Land	Acres		6,445	6,445					25,820	25,820	25,820
Land Stabilization	Acres		930	930		9,200	9,200		9,200	9,200	18,400
Technical Assistance						54,530	54,530		46,450	46,450	100,980
SCS Subtotal						63,730	63,730		492,370	492,370	556,100
Forest Service											
Fire Prevention and Control						2,400	2,400		2,400	2,400	4,800
Contour Trench and Seed	Acres	753		753	59,630		59,630	8,925		8,925	68,555
Spray Sagebrush	Acres	1,600		1,600	5,885		5,885	2,915		2,915	8,800
Range Seeding	Acres	233		233	3,450		3,450	60		60	3,510
Pinyon-Juniper Eradication and Seeding	Acres	940		940	14,100		14,100				14,100
Channel Stabilization	Miles	1.5		1.5	600		600				600
Road and Trail Stabilization	Miles	6.5		6.5	3,300		3,300	2,150		2,150	5,450
Fencing	Miles	19.5		19.5	14,600		14,600	23,960		23,960	38,560
Resource Management (Going Program)								76,810		76,810	76,810
Operation and Maintenance (Installation Period)					10,955		10,955				10,955
FS Subtotal					112,520	2,400	114,920	114,820	2,400	117,220	232,140
Bureau of Land Management											
Pinyon-Juniper Eradication and Seeding	Acres	3,410		3,410	65,580		65,580				65,580
Brush Removal and Seeding	Acres	1,200		1,200	15,670		15,670				15,670
Pipelines (Livestock water)	Miles	3		3				7,665		7,665	7,665
Fencing	Miles	33.5		33.5	9,390		9,390	30,425		30,425	39,815
Resource Management (Going Program)								13,800		13,800	13,800
Operation and Maintenance (Installation Period)					200		200				200
BLM Subtotal					90,840		90,840	51,890		51,890	142,730
TOTAL LAND TREATMENT					203,360	66,130	269,490	166,710	494,770	661,480	930,970
STRUCTURAL MEASURES											
Soil Conservation Service											
Dams, Diversion	Number		3	3		43,700	43,700		43,700	43,700	87,400
Irrigation Canals (Main)	Feet		72,020	72,020		248,710	248,710		248,710	248,710	497,420
Irrigation Canals (Lateral)	Feet		68,480	68,480		79,260	79,260		79,260	79,260	158,520
Irrigation Pipeline	Feet		31,300	31,300		40,990	40,990		40,990	40,990	81,980
Debris Basins											
Sand-"H" Canyons	Number		1	1		205,000	205,000				205,000
Bertlesen Canyon	Number		1	1		84,000	84,000				84,000
Streambank Protection	Feet	1,415	500	1,815	84,530	32,040	116,570				116,570
Wildlife Watering Facilities	Number	3		3	500		500	500		500	1,000
SCS Subtotal					85,030	733,700	818,730	500	412,660	413,160	1,231,890
Installation Services											
Soil Conservation Service											
Engineering Services					14,510	200,850	215,360				215,360
Other Services					6,825	91,745	98,570				98,570
SCS Subtotal					21,335	292,595	313,930				313,930
Subtotal - Installation Services					21,335	292,595	313,930				313,930
Other Costs											
Land, easements and R/W									90,780	90,780	90,780
Administration of Contracts								2,250	46,070	48,320	48,320
Subtotal - Other								2,250	136,850	139,100	139,100
TOTAL STRUCTURAL MEASURES					106,365	1,026,295	1,132,660	2,750	549,510	552,260	1,684,920
TOTAL PROJECT					309,725	1,092,425	1,402,150	169,460	1,044,280	1,213,740	2,615,890
SUMMARY											
Subtotal SCS					106,365	1,090,025	1,196,390	2,750	1,041,880	1,044,630	2,241,020
Subtotal FS					112,520	2,400	114,920	114,820	2,400	117,220	232,140
Subtotal BLM					90,840		90,840	51,890		51,890	142,730
TOTAL PROJECT					309,725	1,092,425	1,402,150	169,460	1,044,280	1,213,740	2,615,890

1/ Price base current

Date December 1962

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT
(at time of Work Plan Preparation)

Monroe-Annabella Watershed, Utah

Measures	Unit	Applied to Date	Total Cost (Dollars) 1/
LAND TREATMENT			
Soil Conservation Service			
Irrigated Land:			
Irrigation Water Management	Acres	1,056	$ 1,850
Conservation Cropping System	Acres	4,334	41,175
Drainage	Acres	40	2,400
Farm Ponds and Irrigation Storage Reservoirs	No.	22	6,050
Irrigation Ditch and Canal Lining	Feet	19,828	66,425
Water Control Structures	No.	2,647	15,880
Pasture Proper Use	Acres	250	4,950
Pasture Planting	Acres	341	7,640
Rangeland:			
Range Seeding	Acres	32	255
Range Proper Use	Acres	4,333	39,865
Forest Service - Fishlake National Forest			
Range Seeding	Acres	150	2,250
Fencing	Miles	1.5	2,400
Resource Management	Acres	40,375	76,810
Bureau of Land Management			
Resource Management	Acres	40,620	13,810
STRUCTURAL MEASURES			
Soil Conservation Service			
Irrigation Canals or Laterals	Feet	145,371	254,400
Irrigation Pipelines	Feet	174	550
TOTAL	XXXX	XXXXXXX	$536,710

1/ Price base 1962 December 1962

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION

Monroe-Annabella Watershed, Utah

(Dollars) 1/

Structure Site No. Or. Name	Installation Cost - P.L. 566 Funds				Installation Cost - Other Funds				Total Installation Cost
	Construction	Installation Services		Total P.L. 566	Construction	Other		Total Other	
		Engineering	Other			Admin. of Contracts	Easements and R/W		
Agricultural Water Management									
Dams, Diversion	43,700	14,855	6,990	65,545	43,700	4,375	8,740	56,815	122,360
Irrigation Canal Lining (Main)	248,710	84,560	39,795	373,065	248,710	24,870	49,745	323,325	696,390
Irrigation Canal Lining (Lateral)	79,260	26,950	12,685	118,895	79,260	7,925	15,850	103,035	221,930
Irrigation Pipeline	40,990	13,935	6,560	61,485	40,990	4,100	8,195	53,285	114,770
Flood Prevention									
Debris Basins:									
Sand-"H" Canyon	205,000	37,850	16,400	259,250		3,000	6,000	9,000	268,250
Bertlesen Canyon	84,000	17,250	6,750	108,000		1,000	1,250	2,250	110,250
Streambank Protection	116,570	19,790	9,310	145,670		3,000	1,000	4,000	149,670
Recreational Measures									
Wildlife Watering Facilities	500	170	80	750	500	50		550	1,300
GRAND TOTAL	818,730	215,360	98,570	1,132,660	413,160	48,320	90,780	552,260	1,684,920

1/ Price base current.

December 1962

TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Monroe-Annabella Watershed, Utah

(Dollars) 1/

Item	Purpose			
	Flood Prevention	Agricultural Water Management	Recreation	Total
(1)	(2)	(3)	(4)	(5)
		COST ALLOCATION		
Single Purpose	528,170	1,155,450	1,300	1,684,920
Total	528,170	1,155,450	1,300	1,684,920
		COST SHARING		
P.L. 566	512,920	618,990	750	1,132,660
Other	15,250	536,460	550	552,260
Total	528,170	1,155,450	1,300	1,684,920

1/ Price base current Date December 1962

TABLE 3 - STRUCTURE DATA

DEBRIS BASINS

Monroe-Annabella Watershed, Utah

ITEM	UNIT	STRUCTURE NAME Sand-"H"	Bertlesen	TOTAL
Drainage Area	sq. mi.	3.0	0.5	3.5
Storage Capacity				
Sediment	ac. ft.	80	36	116
Floodwater	ac. ft.	54	17	71
Total	ac. ft.	134	53	187
Surface Area				
Sediment Pool	ac.	12.6	7.5	20.1
Floodwater Pool	ac.	14.8	8.4	23.2
Volume of Fill	cu. yds.	158,100	60,200	218,300
Elevation Top of Dam (m.s.l.)	ft.	5450.0	5582.0	XXXX
Maximum Height of Dam (approx.)	ft.	18	14	XXXX
Emergency Spillway				
Crest Elevation (m.s.l.)	ft.	5445.0	5577.0	XXXX
Bottom Width	ft.	60	34	XXXX
Type--Excavated Earth				
Percent Chance of Use		1	1	XXXX
Ave. Curve No. - Cond. II		76	87	XXXX
Emergency Spillway Hydrograph				
Storm rainfall (6 hr.)	in.	4.0	4.0	XXXX
Storm runoff	in.	1.74	2.64	XXXX
Velocity of flow (Vc) 1/	ft./sec.	7.0	6.6	XXXX
Discharge rate	c.f.s.	700	340	XXXX
Max. w.s. elev. (m.s.l.) 1/	ft.	5547.83	5579.55	XXXX
Freeboard Hydrograph				
Storm rainfall (6 hr.)	in.	6.0	6.0	XXXX
Storm runoff	in.	3.38	4.51	XXXX
Velocity of flow (Vc) 1/	ft./sec.	10.3	7.2	XXXX
Discharge rate 1/	c.f.s.	1,760	790	XXXX
Maximum w.s. elev. (m.s.l.) 1/	ft.	5449.73	5581.04	XXXX
Principal Spillway 2/				
Capacity-water surface @ crest of emerg.	c.f.s.	30	15	XXXX
Capacity Equivalents				
Sediment Volume	in	0.50	1.35	XXXX
Retarding Volume	in.	0.34	0.64	XXXX
Spillway Storage	in.	0.48	1.41	XXXX
Class of Structure		b	b	XXXX

1/ Maximum during passage of hydrograph

2/ Sand-"H" Canyon structure has two ported risers and outlets, each having a maximum capacity of 15 c.f.s. The Bertlesen Canyon structure has only a single riser and outlet

December 1962

TABLE 4 - ANNUAL COST

Monroe-Annabella Watershed, Utah

Evaluation Unit	Amortization of Installation Cost	Operation and Maintenance Cost	Total
AWM Measures	2/		
Monroe Irrigation Company-Diversion and Lining	$15,640	$ 920	$16,560
Monroe Irrigation Company-Lateral Lining	6,905	410	7,315
Annabella Irrigation Company-Diversion and Lining	14,130	835	14,965
Dry Creek Irrigation Company-Pipeline and Lining	4,740	280	5,020
Soil Conservation District-Diversion and Canal Lining	2,430	135	2,565
Subtotal	43,845	2,580	46,425
Flood Prevention			
Sand-"H" Canyon Debris Basin	10,180	300	10,480
Bertesen Debris Basin	4,185	150	4,335
Streambank Protection-Monroe Canyon	5,680	250	5,930
Subtotal	20,045	700	20,745
Recreational Development	50	20	70
Subtotal	50	20	70
GRAND TOTAL	$63,940	$3,300	$67,240

1/ Price base-current
2/ Amortized 50 years @ 2 7/8%

Date December 1962

TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Monroe-Annabella Watershed, Utah

(Dollars) 1/

Item	Estimated Average Annual Damage: Without Project	Estimated Average Annual Damage: With Project	Damage Reduction Benefits
(1)	(2)	(3)	(4)
Floodwater			
Crop and Pasture	$ 1,115	$ 40	$ 1,075
Other Agricultural	2,755	170	2,585
Roads and Streets	4,430	425	4,005
Power and Water Utilities	1,735	255	1,480
Urban Property	890		890
Subtotal	$10,925	$ 890	$10,035 2/
Sediment			
Crop and Pasture	$ 2,215	$ 125	$ 2,090
Other Agricultural	5,780	475	5,305
Roads and Streets	1,010		1,010
Power and Water Utilities	895	345	550
Urban Property	1,455		1,455
Subtotal	$11,355	$ 945	$10,410 2/
Erosion			
Gully	$ 2,190	$1,105	$ 1,085
Subtotal	$ 2,190	$1,105	$ 1,085
Indirect	$ 2,320	$ 195	$ 2,125 2/
Total	$26,790	$3,135	$23,655 2/

1/ Long term costs and prices Date December 1962

2/ Includes $1,210 in downstream effects of upper watershed land treatment.

TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Monroe-Annabella Watershed, Utah

(Dollars) 1/

Evaluation Unit	AVERAGE ANNUAL BENEFITS					Average Annual Cost	Benefit Cost Ratio
	Flood Prevention						
	Damage Reduction	Secondary Benefits	Agr. Water Management	Recreational Development	Total		
Monroe Irrigation Company							
Diversion and Lining			30,460		30,460	16,560	1.8 to 1
Lateral Lining			20,005		20,005	7,315	2.7 to 1
Annabella Irrigation Company							
Diversion and Lining			23,535		23,535	14,965	1.6 to 1
Dry Creek Irrigation Company							
Pipeline and Lining			16,950		16,950	5,020	3.4 to 1
Soil Conservation District							
Diversion and Lateral Lining			4,250		4,250	2,565	1.7 to 1
Subtotal			95,200		95,200	46,425	2.1 to 1
Flood Prevention							
Sand-"H" Canyon Debris Basin	9,645	5,210			14,855	10,480	1.4 to 1
Bertlesen Canyon Debris Basin	4,230	1,060			5,290	4,335	1.2 to 1
Streambank Protection	7,485	615			8,100	5,930	1.4 to 1
Subtotal	21,360	6,885	~~25,200~~		28,245	20,755	1.4 to 1
Recreational Development				300	300	70	4.3 to 1
Subtotal				300	300	70	4.3 to 1
GRAND TOTAL	21,360	6,885	95,200	300	123,745	67,240	1.8 to 1

1/ Price base - costs - current prices Benefits - Long term prices

2/ In addition, it is estimated that land treatment measures will provide flood damage reductions of $1,210 annually, and a reduction of gully erosion damages of $1,085 annually.

TABLE 7 - CONSTRUCTION UNITS

Monroe-Annabella Watershed, Utah

(Dollars) 1/

Measures in Construction Unit	Annual Benefit	Annual Cost
(1)	(2)	(3)
Debris Basins		
Sand-"H" Canyon	$14,855	$10,480
Bertlesen	5,290	4,335
Streambank Protection		
Monroe Canyon	8,100	5,930
Irrigation System Improve.		
Monroe Irrigation Co.		
Main Canal and Div.	30,460	16,560
Lateral Lining 2/	20,005	7,315
Annabella Irrigation Co.		
Main Canal and Div.	23,535	14,965
Dry Creek Irrigation Co.		
Pipeline and Canal Lining	16,950	5,020
Other AWM Structures (Sevier County SCD)		
Monroe Creek Diversion		
Lateral Lining 3/	4,250	2,565
Recreational Development	300	70

1/ Costs at current (1962) prices Date December 1962

2/ 14 laterals in construction unit

3/ 2 laterals in construction unit

PROJECT FORMULATION

Investigations were planned jointly by the participating agencies and carried out to determine the effects of the land treatment and structural program on watershed problems.

The sponsoring local organizations and the participating agencies determined areas requiring accelerated land treatment measures. The land administering agencies outlined the treatment measures on Federal land. The Utah State Department of Forestry and Fire Control determined additional fire control equipment needs. The Utah State Department of Fish and Game outlined land treatment measures on Utah State Department of Fish and Game land and State land leased by the Department. The Soil Conservation Service, local sponsors and ranchers outlined the treatment program for private and other State land. The sponsoring local organizations and the participating agencies formulated the land treatment program from proposals developed.

The Soil Conservation Service and local sponsors jointly investigated alternative proposals for structural treatment and formulated the program. The Forest Service reviewed plans for structural measures on the National Forest.

Land Treatment Measures

Land treatment measures were outlined where investigations showed a need for treatment. The going program is based upon a projection of current application rates with adjustments to reflect trend. The accelerated program is based upon needed acceleration of the going program adjusted to the application rate expected with the project.

Structural Measures

A reconnaissance survey was made of all drainages to determine the magnitude of flood problems. Flood damage surveys were made for each independent drainage where reconnaissance surveys indicated the need. The extent, frequency, and kinds of damage which have occurred from floods of historic record were established. These surveys provided the basis for calculating the present annual damage for each drainage and made up the base from which the projected future flood damage reductions resulting from watershed treatment could be estimated.

Flood prevention structural measures, including alternatives, were outlined where reconnaissance surveys indicated a need. Engineering, Hydraulic, and Geologic investigations and data required to plan the measures and determine their effects on watershed problems were determined. Available survey information and data pertinent to the proposed treatment were collected from files of the Soil Conservation Service and other local, State, and Federal agencies as well as irrigation companies. Needed additional surveys and investigations were planned and carried out.

A water measurement program was initiated for canals and laterals serving the irrigated area. These measurements were made during the 1961 irrigation season and served to supplement existing water supply records and to indicate seepage and operational losses in canals and laterals. These data served as a basis for determining present water supply and to indicate canals and laterals needing lining.

A sample farm study of 16 irrigated farms was conducted comprising about 15% of the irrigated acreage. Data collected during this study were then analyzed and together with data from other watersheds and sources served as a basis for defining the principal irrigation problems and for evaluating present conditions.

Surveys conducted by the Utah State Department of Fish and Game and local hunter experience indicate a low upland game bird population and a high mortality rate among bird broods along the frontal aprons and fans. These factors limit hunter success and hunter opportunity and are the basis for planning the wildlife watering facilities.

Alternative Structural Measures Considered

Alternative debris basin sites were selected for Sand-"H", Bertlesen, and Order-Dugway Canyons. These alternatives were located at low, medium, and high positions on the fans near the mouths of the canyons. Preliminary designs and cost estimates were made and the best sites selected on the basis of cost.

Disposal channels and dikes were investigated as an alternative to the debris basins. A field and map reconnaissance was made of the site and the alternative eliminated on the basis of cost comparisons.

A dike was investigated along the north edge of the Monroe fan to protect Monroe City from flood damage from Monroe Creek. Preliminary designs and costs were approximated, based on field and map reconnaissance. Insufficient benefits were available to support the costs.

A disposal or flood channel was considered to convey excess snowmelt runoff from Monroe Creek through the irrigated area to the Sevier River. Because of the frequency of high magnitude flows, extent of damages, damageable values, and high costs, this proposal was also eliminated.

Numerous other proposals for flood prevention structures were examined from a reconnaissance standpoint. These proposals were not investigated further because of apparent low justification and high cost.

Local sponsoring organizations and Service personnel discussed and formulated a number of alternative proposals for agricultural water management structures. These alternatives included improvement and renovation of small storage reservoirs located on the National Forest, improvement of individual company systems, and system combinations.

Each of the alternatives were examined from a cost standpoint and reviewed with the local sponsors. Benefits, including monetary and physical benefits and costs, were developed for the most acceptable alternatives. The irrigation companies and ditch groups participating in work plan development selected the agricultural water management structural measures included in the work plan after reviewing the benefits and cost. The proposals for storage and system combinations were eliminated on the basis of cost, cost advantage, and water rights.

The Monroe-South Bend and Wells irrigation companies felt that the amount of water to be saved through improvement of their main delivery system would not justify the risk of indebtedness.

The Monroe City Ditch group and the Annabella Reservoir and Canal Company both serve croplands located principally within corporate boundaries of Monroe and Annabella cities. Present policy prevents cost-sharing assistance for improvements on these systems.

The Central Irrigation group, because of the nature of their water rights and their present level of indebtedness, did not consider any improvement to their system practical.

SOILS

Soils in the valley are generally medium textured, deep, and well drained. However, there are small areas of gravelly soils, fine textured soils, and wet soils which are slightly saline. The rangeland soils, located mainly on the foothill and fan areas, consist of gravelly alluvium or shallow colluvium underlain by volcanic rocks. Soils in the mountain and high mountain areas consist of two main types: deep, medium to fine textured, moderately pervious materials on gently sloping topography, and shallow, stony or gravelly material on steep slopes with frequent areas of rock outcrops.

The soils inventory and land capability information for private and State land was obtained from existing SCS standard soil surveys and conservation surveys. Soils were given management capability class ratings on the basis of slope, physical characteristics of the soil, and climatic conditions.

Soils information for National Forest land was obtained from an extensive soil survey made by the Forest Service.

RANGE

Federal Range Land

Field investigations and studies were conducted by the land administering agencies having responsibility for Federal range lands. Vegetative and soil resources, type and extent of erosion, areas producing floodwater and sediment (critical areas) range conditions, and trends were established

and range sites identified. Land treatment measures needed to stabilize critical areas, arrest land deterioration, and provide a balance between forage production and grazing use were outlined. Technicians of the land administering agencies worked closely with the Soil Conservation Service in selecting feasible measures.

Private Range Land

The private range areas were classified into range sites. The range sites are as follows: Semi Desert (stony loam); Semi Desert Shallow (igneous); High Mountain Loam; High Mountain Loam (aspen); High Mountain Loam Timber (woodland site); and Wet Meadow. These sites were further classified as to their present and potential condition, plant composition and density, and forage production.

In general, the range sites are in fair to poor condition. Present usable forage production is usually less than the potential. Needed land treatment measures were selected using existing ranch conservation plans along with data developed from field surveys.

GEOLOGY

Debris Basins

Foundation Investigations

These dams are in site group I and will be less than 20 feet high. Investigations consisted of surficial examinations and backhoe test pits at the Sand-"H" Canyon site. The test pits were dug to determine the character of the borrow material and the alluvial deposits beneath the centerline of the dam.

Disturbed samples were collected from beneath the centerline of the dam and from the borrow area. These samples were submitted to the soils mechanics testing section for permeability, compaction, and routine classification tests. Sufficient borrow materials, (GM, GM-GP, GP, GW, SM, SM-SP, and SP), are available in the reservoir basins to build homogeneous embankments. Cut-off trenches will be excavated about 8 feet deep into the coarse alluvial foundations to remove some of the more permeable, poorly compacted materials and to increase the path of percolation.

These two sites are very similar geologically and topographically. They are both located on recent alluvial fan deposits at the base of a steep escarpment along the Sevier Fault. Bedrock exposed on the mountains above the sites consists of Latite flows, Tuffs, and Breccias of the Bullion Canyon Volcanics. Erosion of these rocks has produced coarse gravels and sands with a minor amount of fines.

The emergency spillways will be excavated in silty, sandy gravels and silty sands and will be quite erodable.

Before final designs are completed, subsurface investigations will be made at each site to determine the character of the foundation material and the exact type and quantity of available borrow.

Channel Investigations

Monroe Creek channel was investigated by the Soil Conservation Service to determine its present stability and to locate areas needing protection to prevent damages to important public utilities. The channel investigations included the following:

1. A base map of Monroe Canyon, between the two power plants, was made showing the location of the road, creek, pipelines, rock outcrops, and existing works of protection along the channel.

2. Channel cross-sections and a profile of the stream were obtained by field survey.

3. Channel characteristics and overbank flow conditions were observed to determine unstable reaches, roughness, soil material, and vegetation.

4. Soil samples, disturbed and undisturbed, were taken to determine grain size and strength of streambank materials.

5. Stage-discharge relationships of the stream channel were computed.

6. Estimates of peak flow for the 50-year frequency summer rainstorms and the 25-year frequency snowmelt runoffs were determined.

7. Channel stress and size of rock riprap required for various depths of flow at each cross-section were determined using tractive force principles.

Monroe Creek is confined in a narrow canyon for a distance of about 1,500 feet below the upper power plant. In this reach, the vertical canyon walls have been cut in Latite flow rocks of the Bullion Canyon Volcanics and rock outcrops alternate with steep colluvial slopes. These talus slopes extend into the stream channel and road right-of-way at several locations.

The canyon bottom in this short reach is approximately 50 to 200 feet wide. The stream channel varies from 30 to 50 feet in width and the channel gradient varies from 5 to 9%. Soil materials exposed in the north channel bank were classified as GP, GM, and GC. The material in the channel bottom consists of cobbles and boulders.

Rubble masonry and rock riprap protection was installed in the more critical sections of this reach in 1937 and 1938 by the Public Works Administration. Some of this existing protection work is now in need of repair and additional areas need protection to prevent damage to the upper power plant, road, and the pipeline which supplies the lower power plant. Because of the narrow width of the canyon, the great stress exerted on the channel by the infrequent large summer rainstorm peaks and the high level of protection required to prevent damages and hold maintenance costs to a minimum, rubble masonry protection has been planned for most of this section.

The lower part of Monroe Creek below "the narrows" is entrenched in a V-shaped canyon cut in Latite flow rocks, Tuffs, and Breccias of the Bullion Canyon Volcanics. Here, the canyon is more open and considerable alluvial fan material has been deposited at the base of the steep colluvial and bedrock slopes. At a few locations, bedrock ledges extend into the canyon bottom and the flow of the stream is deflected against the opposite bank.

Soils in the north bank of the channel were classified as GM, SM, SP-SM, GP, GC-GM, and GC. Materials in the channel bottom consist of gravels, cobbles, and boulders. The channel varies from 25 to 100 feet in width and channel gradient varies from 4 to 9%.

Protection is needed in this reach to prevent damage to the culinary water line for Monroe City, the supply pipeline for the lower power plants, and the road up Monroe Canyon. Grouted rock riprap is planned for this section of the canyon to provide protection comparable to that planned for the upper reach.

Peak annual snowmelt discharges from Monroe Canyon generally range from 50 to 100 c.f.s. The 25-year frequency snowmelt peak discharge was estimated to be 250 c.f.s. at the irrigation diversion near the canyon mouth. A peak discharge of 2,200 c.f.s. was estimated for the 50-year frequency short-duration summer rainstorm runoff at the same location.

Rock for grouted riprap and rubble masonry construction is available in the canyon by utilizing the material on the talus slopes and in the channel bottom. This rock can be obtained with a minor amount of road building.

Detailed surveys and studies will be made before final designs are completed to more accurately determine the location of needed protection and to obtain additional channel data for the unstable sections.

SEDIMENTATION

Some sedimentation data were available for the watershed from flood control surveys made in the Sevier River Basin. A sedimentation survey had been made of the Magleby Reservoir and a general erosion and sediment source map had been prepared for part of the watershed area. Rough calculations had been made on sediment yields from Sand and Bertlesen Canyons.

Investigations made to develop this work plan consisted of:

1. Measurements of recent flood deposits on alluvial fans.
2. Grain size analysis studies on alluvial fans.
3. Gully void measurements in the upper watershed.
4. Plant cover-condition and soils inventory.

Erosion rates and sediment yields are quite high in the foothill and intermediate areas of the watershed because of the large number of short, steep drainages, the sparse vegetative cover, and the poorly developed, noncohesive soils. Gully and rill erosion are the principal types of erosion present.

Erosion and sediment production are moderate on the upper watershed because of better vegetal cover, moderate slopes, and cohesive soils. Several small, closed basins exist because of landslide topography and minor glacial deposits. Sheet erosion is the dominant type of erosion.

Most of the erosion and sediment yield results from summer flash floods. These floods carry large quantities of rock and debris; and mudflow deposits are evident on some of the alluvial fans. Monroe Creek is the only drainage large enough to have substantial sediment movement during the snowmelt runoffs.

Based on the plant cover condition inventory and existing grazing controls, it has been estimated that future sediment production will be reduced 20 per cent after the land treatment program is fully effective. This reduction has been used to compute physical benefits resulting from watershed treatment and management.

By using computed runoff volumes for the various flood frequencies and sediment yields determined from measurements of recent fan deposits, sediment delivery volumes were obtained for several flood events. This was accomplished by plotting sediment curves parallel to the runoff curves and adjusting their position to obtain the computed 50-year sediment yield. Sediment delivery volumes for the 100, 50, 25, 10, 5, and 2-year frequency rainstorm runoff events are listed below for several drainage areas which were analyzed for flood damages:

Frequency of Occurrence-Years	Estimated sediment delivery, in acre feet, for various frequency flood events --- Present Conditions		
	Sand and "H" Canyons	Bertlesen Canyon	Bertlesen-Sand Canyon Face
100	36.0	7.0	5.0
50	24.0	5.2	3.7
25	15.0	3.7	2.7
10	7.2	2.2	1.6
5	3.7	1.3	1.0
2	1.0	0.5	0.4

The sediment storage required in the two proposed debris basins is rather high. The following table gives sediment data pertinent to these two structures:

Proposed Site	Sand and "H" Canyon Site	Bertlesen Canyon Site
Drainage area - square miles	3.0	0.5
Computed 50-year sediment yield - acre feet	159	48
Estimated deposition on alluvial fan upstream from structure - %	50	30
Estimated trap efficiency - %	90	90
Sediment storage required below crest of emergency spillway - acre feet	80	36
Equivalent sediment yield (over entire watershed) - inches	1.0	2.0

ENGINEERING

Investigations and Designs

Flood Prevention Structures

Debris Basins: A topographic map was made by the Kelsh Plotter Method covering the fan area above Monroe City to locate possible sites. Alternative sites were then selected and preliminary designs and cost estimates were made. Final selection of the sites included in the work plan were based upon these preliminary costs and relative effectiveness of the structures in solving watershed problems. After selection of the most feasible sites, a strip topographic survey was made for the Sand-"H" Canyon structure and test pits were dug and material tests made. The Kelsh Plotter map was field checked for the Bertlesen site and found to be suitable for work plan purposes. Foundation and available fill material at the Bertlesen site were judged to be similar to the Sand-"H" Canyon site.

These structures are located low on alluvial fans some distance from the base of the mountains. Average slopes on the fans in the vicinity of the sites range from 5-10%. The structures will consist of an earth embankment, a restricted-flow principal spillway, an emergency spillway excavated in earth and an excavated basin area. Training dikes are planned for the

Sand-"H" Canyon site to give more protection to the damage area below the Sand and "H" Canyon fans, to direct runoff into the basin storage area and to provide greater safety in the operation of the structure by preventing deposition in the emergency spillway.

The principal spillway consists of a restricted-flow reinforced concrete riser and a 30-inch diameter reinforced concrete pipe outlet conduit. Each principal spillway will have a maximum outflow of approximately 15 c.f.s. which downstream channels can safely accommodate. The Sand-"H" Canyon structure is provided with two such principal spillways because of the length of storage area.

Because of the low relative costs for the principal spillways in comparison with other structural items, only general features were recognized in designs and volume estimates.

The earth emergency spillways of each structure are proportioned to pass the Emergency Spillway Hydrograph at the safe velocity for the site and will also pass the Freeboard Hydrograph with the maximum water surface below the settled height of dam in accordance with criteria for a class (b) structure as outlined in Engineering Memorandum SCS-27.

The training dike for the south wing of the Sand Canyon site is designed with a 14 foot top width, 3:1 side slopes upstream, 2:1 slopes downstream, and a settled centerline height of 10 feet. The training dike provided for "H" Canyon is designed with a 14 foot top width, 10 foot settled centerline height, 2:1 side slopes both sides, and 2 feet of riprap on the exposed slope to extend 3 feet vertically above and below the toe.

Results of soil materials testing and geologic observations on the sites indicate no particular difficulty from the foundation or construction material standpoint. However, additional foundation explorations and soils tests will be made before construction designs are prepared.

Streambank Protection: Rubble masonry and grouted rock riprap were proposed to protect specific reaches of streambank and contingent fixed improvements from repeated damage from summer flash floods. They will also protect these improvements from snowmelt flows. Rubble masonry was designed for reaches of channel where space is limited due to narrowness of gorge section and proximity of fixed improvements to channel banks. Grouted rock riprap was designed for more open areas of channel bank where space is not limited. Typical sections and locations may be found on Figure 7. Additional information concerning designs may be found under "Geology, Channel Investigations."

Agricultural Water Management Structures

Conservation plans developed for irrigation company systems and engineering plans and estimates for specific structures have been developed by the irrigation companies and individuals cooperating with the Sevier County Soil Conservation District. Additional field surveys were made and design

and cost estimates adjusted to reflect current construction techniques, material, procedure, and local costs. Designs and cost estimates were also made for alternative proposals. Water-loss measurements were conducted to delineate the extent of needed lining and regulating structures prior to planning the measures.

Designs for measures included in the work plan are based upon standard design procedures of the Soil Conservation Service used in the local Soil Conservation District program.

Recreational Measures

Designs and costs for the wildlife watering facilities for upland game birds were developed by the Utah State Department of Fish and Game. Designs and costs are based upon experience gained in similar installations under similar conditions.

Land Treatment Program

The going program of the Sevier County Soil Conservation District was analyzed to determine the accelerated on-farm land treatment program needed. Engineering phases included the determination of size, extent, and unit cost of treatment measures.

Costs

Preliminary designs and cost estimates were prepared for alternative structural measures. The most economical designs and measures were selected which most nearly meet the requirements of the project. Quantities of construction material were computed for the structural measures selected.

Estimated costs were based upon construction quantities and unit costs. Unit costs were taken from bid item schedules for work recently completed under contract in the vicinity modified by differences in site conditions. These differences include location, topography, geologic characteristics, size of construction bid items, and the availability and accessibility of materials.

Designs and cost estimates for the streambank protection measures in Monroe Canyon were prepared by the Soil Conservation Service. The Forest Service has reviewed these plans and site locations and have concurred in the designs.

Cost Sharing

Specific costs to be borne by P.L. 566 funds are detailed in tables 1 and 2 and outlined under "Explanation of Installation Costs."

Land Treatment Measures

Assignment of accelerated technical assistance cost to P.L. 566 funds was based upon additional assistance required for installation of accelerated land treatment measures on non-Federal land in excess of that expected to be available under going programs.

Sharing of installation cost for land treatment measures on Utah State Department of Fish and Game land and State land leased by the Department is based upon the ratio of cost-sharing assistance currently authorized under other programs for critical area stabilization within the watershed.

Sharing of installation cost for fire control equipment is based upon the ratio of cost-sharing assistance currently authorized under other programs within the watershed.

Assignment of installation costs for land treatment measures on Federal land was made on the basis that: (1) the land administering agencies would continue their going programs at least at the current rate; (2) P.L. 566 funds would bear the cost for needed accelerated treatment to prevent land deterioration; (3) the land administering agencies would bear the cost of management facilities; such as fences, water development, and other treatment which is necessary for management to gain the maximum effect of the land stabilization measures.

Structural Measures

Sharing of costs for agricultural water management structural measures is based upon P.L. 566 funds bearing 50% of the construction cost and all installation services costs, and other funds bearing 50% of the construction cost and all costs for land rights and contract administration.

Sharing of costs for flood prevention structural measures is based upon P.L. 566 funds bearing all construction and installation services costs, and other funds bearing all costs for land rights and contract administration.

Sharing of cost for the recreational structural measures (wildlife watering facilities) is based upon P.L. 566 funds bearing 50% of the construction cost and all installation services costs, and other funds bearing 50% of the construction cost and all costs for contract administration. Because the recreational measures will be installed on National Land Reserve (BLM), no land rights costs are involved.

Cost Sharing Summary for Structural Measures

For Agricultural Water Management:

	P.L. 566	Other	Total
Construction Cost	$412,660	$412,660	$825,320
Installation Services	206,330		206,330
Other Costs		123,800	123,800
Installation Cost	$618,990	$536,460	$1,155,450

For Flood Prevention:

	P.L. 566	Other	Total
Construction Cost	$405,570		$405,570
Installation Services	107,350		107,350
Other Costs		$15,250	15,250
Installation Cost	$512,920	$15,250	$528,170

Recreational Measures

	P.L. 566	Other	Total
Construction Cost	$ 500	$ 500	$1,000
Installation Services	250		250
Other Costs		50	50
Installation Cost	$ 750	$ 550	$1,300

HYDROLOGY

Basic procedures used in hydrologic investigations are outlined and described in the Soil Conservation Service National Engineering Handbook, (NEH), Section 4, Hydrology-Supplement A (Hydrology Guide).

Hydrologic studies were primarily concerned with: (1) evaluating the on-site and off-site effects of the land treatment measures to be installed on the mountainous and lower elevation range areas; (2) determining present and future peak flow-runoff series for the proposed debris basin sites; (3) computing structural design hydrographs and flood routings for the proposed debris basins; and (4) determining peak flow-frequency relationships for lower Monroe Canyon.

All other hydraulic and hydrologic investigations concerned with the agricultural water management measures are under a following section entitled, "Agricultural Water Management Investigations."

Basic Data Available

Climatological Data

There are no Weather Bureau stations or historical climatological records available within the watershed. The closest station, Richfield, (Radio Station KSVC, elevation-5,300'), is some 10 miles north of the town of Monroe. This station, having both recording and non-recording gages, has some 42 years of temperature record and 43 years of precipitation record.

There are no snow courses located within the watershed. There are two courses in adjacent drainages (southeast of the watershed), at elevations of 9,300 and 9,800 feet, which have records since 1954.

Rainfall intensity frequency values, available from Weather Bureau Technical Paper No. 40 (May 1961), were increased slightly to the amounts shown below to better reflect local orographic influences and records of past storm events.

Frequency of Occurrence--Yrs.	100	50	25	10	5
Point Rainfall (Short-duration)-In.	1.86	1.62	1.38	1.10	0.90

Streamflow Data

There are no streamgaging station records available for streams originating in the watershed. On the Sevier River, which forms the project's western boundary, U. S. Geological Survey streamflow records for the reach from below Piute Reservoir to near Sigurd were available and analyzed (including the Clear Creek stations). These river discharge records, the earliest of which began in 1911, were studied in conjunction with the annual water distribution reports of the Sevier River Water Commissioners, which were available for 1934-1961. These annual reports to the State Engineer include the average daily discharges recorded at the heads of the five canals diverting water from the river into the irrigated portion of the watershed.

Local Flood Records

Newspaper accounts and pictures, reports of the Forest Service, Corp of Engineers, Weather Bureau, and Geological Survey concerning severe local storms and damaging flood runoffs were available and studied.

Data from the 1950 Sevier Lake Watershed Survey Report and Appendices, which covered all of the watershed area, were available and used.

Hydrologic Condition Data

Range site and condition surveys were available as part of existing ranch conservation plans on private rangeland. Results of infiltrometer studies made by the Forest Service on this and similar watersheds having comparable soil-cover complexes were available to check estimates of runoff.

Investigations

Watershed Hydrologic Conditions

A soils-plant cover mapping survey was made by Forest Service personnel on all critical floodwater and sediment producing areas, other deteriorating areas, and on a considerable portion of the remaining National Forest land in the watershed. A hydrologic condition map and a land treatment and problem area map were also compiled by the Forest Service.

Hydrologic conditions of the private and State-owned rangeland were determined by a limited amount of field survey and correlation, principally in the lower to intermediate elevation areas. Co-operative field studies between the Soil Conservation Service, the Bureau of Land Management, and the Utah State Department of Fish and Game were made on the areas for which treatment measures are proposed.

Runoff curve numbers were assigned to each soil-cover complex, based on its hydrologic condition, land use and treatment, soils data, and in accordance with previous infiltrometer field studies in this area. An average antecedent moisture condition (II) was used in all runoff determinations. The majority of the upland soils were in the B group, having above-average infiltration rates.

Estimation of Direct Runoff and Evaluation of Land Treatment

Using the runoff curve numbers for the estimated hydrologic conditions under both present and future conditions, with and without a watershed project, a synthetic evaluation series for the 100, 50, 25, 10, and 5-year rainstorm runoff volumes was determined for each drainage area where treatment measures were proposed.

The Forest Service evaluated the on-site effects of their treatment measures in reducing runoff by applying 1 to 2 inch point rainfall depths over each problem area. The only treatment planned above the debris basins is in upper Sand Canyon, where 130 acres on the National Forest will be contour trenched and reseeded with grass and browse, the juniper to be chained and windrowed on the contour, between the trenches.

Off-site runoff reductions expected to be achieved through the land treatment program were estimated by the Soil Conservation Service at the mouth of each drainage area where downstream floodwater damages are occurring.

Estimated Peak Flows in Lower Monroe Canyon

In order to plan the measures necessary to protect the canyon road and the culinary and power pipelines in lower Monroe Canyon, peak discharges for the 50-year frequency short-duration summer rainstorm and for the 25-year frequency spring snowmelt runoff events were determined for the mouth of the canyon, in the vicinity of the lower power plant. The 50-year frequency summer peak was based on a 1.62 inch point rainfall over an approximate 10 square mile drainage area, using the weighted II condition runoff curve number determined from the soil-cover complexes present.

The estimated 25-year frequency snowmelt peak discharge was based on a regional analysis using records of nearby gaged streams having drainages of a type similar to Monroe Canyon.

Structural Design Hydrographs

Design hydrographs for the two class (b) debris basins were developed in accordance with Soil Conservation Service standards set forth in Part 3.21 of Supplement A, Section 4 of the NEH and criteria set forth in Engineering Memorandum SCS-27 (Rev. 3-14-58).

Rainfall depths used to develop the two hydrographs which affect the design of the emergency spillways were obtained from the maps accompanying SCS Advisory Notice W-2018, dated 11/17/61 (Figures 21.6 and 21.7).

Since the principal spillways are planned to have restricted-flow risers and maximum outflow capacity of approximately 15 c.f.s., the floodwater retarding capacity provided in each debris basin is sufficient to contain the entire Principal Spillway Hydrograph (100-year frequency of occurrence short-duration rainstorm having a storm depth of 1.86 inches) between the top of the level sediment pool and the crest of the excavated emergency spillway.

A 6-hour duration rainstorm having a point rainfall of 6.0 inches was used to compute the Freeboard Hydrograph for the Sand-"H" Canyon site. Because of the small drainage area (278 acres), and short time to peak, the Freeboard Hydrograph for the Bertlesen Canyon structure was developed using a peak inflow obtained from a one-hour rainfall of 3.6 inches and a runoff volume obtained from the six-hour point rainfall of 6.0 inches. Routing the Freeboard Hydrograph, beginning at the top of the level sediment pool, determined the minimum capacity of the emergency spillway and also was the basis for establishing the elevation of the settled top of the dam.

A 6-hour duration storm having a point rainfall of 4.0 inches was used to compute the Emergency Spillway (Design) Hydrograph for the Sand-"H" Canyon site. Again, for the Bertlesen Canyon structure, the Emergency Spillway Hydrograph was developed using a peak inflow obtained from a 1-hour point rainfall of 2.4 inches and a runoff volume obtained from the 6-hour point rainfall of 4.0 inches. Routing the Emergency Spillway Hydrograph through the basin, starting at the top of the level sediment pool, was the basis for the selection of the proper design and proportion of the emergency spillway control section and outlet channel. The storage-indication method was used for all flood routing through the debris basins.

Hydrologic and related hydraulic design data for the two debris basins are shown in Table 3 of this work plan.

AGRICULTURAL WATER MANAGEMENT

General

All of the 12,200 acres of presently irrigated land in the watershed will be benefited by the measures proposed. There are approximately 11,300 acres of irrigated cropland and some 900 acres of native pasture or meadowland now under irrigation. Some 9,720 acres of the total irrigated area are under the five irrigation companies which divert directly out of the Sevier River, (Monroe-South Bend, Wells, Monroe, Brooklyn, and Annabella).

There are eleven separately organized irrigation companies or groups within the watershed. Presently, there is a total of some 188 irrigated farming units. No new land is proposed for irrigation. All irrigated land to be affected by the proposed agricultural water management measures are under existing systems.

Basic Data Available

Soils

Soils in the irrigated area are divided into five treatment groups:

Group 1--Well drained, moderately coarse to moderately fine textured (medium and moderately fine most common), and more than 36 inches deep. Slopes range from 0-3%. Moisture holding capacity is fair to good, with the moderately coarse soils holding about 1.2 inches per foot and the moderately fine, 2.2 inches per foot of soil. There are small areas of gravelly soils intermixed with these deep soils. L.C.U.- IIc4, IIe1, IIs3, and IIs4; about 7,000 acres.

Group 2--Well drained, gravelly, moderately coarse to medium textured, underlain by gravel found from near the surface to 36 inches deep, with most of the gravel found between 10 and 20 inches. Slopes range from 0-6%. Moisture holding capacity of the soil material above the gravel ranges from 1.2 - 2.0 inches per foot. The underneath gravelly material holds from 0.5 - 1.0 inches per foot of depth. Some locations have a strong zone of lime accumulation in the upper part of the gravel. Small areas of deep IIs4 soils too small to map separately are included in this category. L.C.U.- IIs4, IIIs4, and IIIe1s4; about 3,550 acres.

Group 3--Well and moderately well drained, fine textured, deep soils with slopes ranging from 0-1%. These clay soils have a slow permeability and an available moisture holding capacity of about 2.2 inches per foot of soil depth. This group includes small areas slightly to moderately affected by a high watertable, some with slight to moderate salinity, and some stratification of sand. L.C.U.- IIIs3 and IIIs3w1; about 750 acres.

Group 4--Soils in this area, located along the Sevier River, are predominantly riverwash material, mainly sand and gravel. Slopes range from 0-2%, only a small portion of this area is suitable for grazing. L.C.U.- VIIIs4; about 600 acres.

Group 5--Deep, imperfectly and poorly drained soils varying widely in texture within a short distance. Texture ranges from coarse to fine--the most common texture being moderately coarse to moderately fine. Some of these soils have moderate to strong salinity, with a limited amount of alkalinity. The main use is for native pasture and saltgrass meadow. Generally, they are not suited for cultivation. Slopes range from 0-1%. L.C.U.- IVw1s4, IVw1s5, VIw1s5, and VIs5w1; about 900 acres.

Sub-class symbols shown above on the land capability units refer to the following limitations: c4--temperature; e1--slopes; s3--fine textured; s4--coarse textured or gravelly; s5--salinity; and w1--watertable.

The predominant soil series in the irrigated area include Bertlesen, Jura, Monroe, and Ralson.

Climatological Data

The irrigated area ranges in elevation between 5,300 and 5,600 feet and has a mean latitude of approximately 38°-39'N. Mean frost-free periods, (1921-1950) for the closest Weather Bureau station--Richfield (Radio KSVC), are as follows:

Threshold Temperature °F	Mean Data of Occurrence		Mean No. of Days
	Spring	Fall	
32	May 20	Sept. 26	129
28	May 6	Oct. 5	152
24	April 19	Oct. 21	185

Monthly mean temperatures and median precipitation for the Richfield station, elevation 5,300 feet, for the growing season are as follows:

Month	Mean Temperature 1/ (°F)	Median Precipitation 2/ (Inches)
April	48.5	0.66
May	56.7	0.61
June	64.5	0.24
July	71.8	0.71
August	70.0	0.90
September	61.9	0.58
October	51.0	0.63

1/ 1931-1955 Weather Bureau mean values
2/ 1889-1961 median monthly values

Cropping Pattern

The irrigated lands are composed of three priority categories:

1st priority--annual row crops, small grains, and new plantings of alfalfa and tame grass (usually with a nurse crop);

2nd priority--alfalfa and improved (tame) pasture; and

3rd priority--native, river bottom pasture or meadowland (900 acres).

First and second priority crops extend over 11,300 acres.

The following cropping pattern generally prevails over most of the irrigated area (under non-project conditions):

1st Priority Crops		2nd Priority Crops	
Corn silage -	10%	Alfalfa -	60%
Sugar beets -	6%	Imp. pasture -	9%
Potatoes -	4%		
Small grain -	2%	Subtotal	69%
New alfalfa and grass -	9%		
Subtotal	31%		

Water Supply

The principal source of supply for the 12,200 acres of land is the Sevier River. Streams rising in the mountainous eastern portion of the watershed, including Dry Canyon, Live Oak, Birch Springs, Corner, Monroe, Jensen, Thompson, Norton, Cottonwood, Cliff, and Maple Canyons are also important sources of irrigation supply. However, the majority of them, especially the smaller drainages, flow only during periods of snowmelt or excess precipitation. These tributary streams have no available records of streamflow or irrigation yield.

Annual water distribution reports of the Sevier River Water Commissioners to the State Engineer were available for the period 1934-1961. These reports show the average daily discharge recorded at the heads of the five canals diverting water from the Sevier River into the watershed area.

Investigations

Irrigation Requirements

Monthly consumptive-use was computed by the modified Blaney-Criddle method, using a local percent of daylight hours, mean monthly temperatures, and a variable monthly crop coefficient "k". Since sufficient moisture to replace any soil moisture deficiency will be available from precipitation and irrigation during the non-growing season, an end of growing season moisture depletion

of 2.0 inches was allowed in determining the net irrigation requirement (NIR). Median monthly precipitation, based on the 1889-1961 period, was also deducted from the monthly consumptive-use amounts to obtain the NIR.

The accompanying table gives the monthly net irrigation requirement in inches for the crops shown locally (effective precipitation and the end of season soil moisture depletion have been deducted):

Average Monthly Net Irrigation Requirements in Inches

Crop	April	May	June	July	Aug.	Sept.	Oct.	Total
Improved (Tame) Grass Pasture	1.19	2.74	4.50	5.52	4.53	1.72*	0.00*	20.20
Alfalfa	0.77	3.11	4.91	6.06	5.07	1.67*	0.00*	21.59
Sugar Beets		1.11	3.58	5.90	5.77	3.43*	0.00	19.79
Small Grains	0.42	2.37	5.43	3.72*				11.94
Potatoes		0.20	2.59	5.72	5.37	1.31*		15.19
Corn Silage		0.45	2.85	5.72	5.37	1.51*		15.90

* Soil moisture depletion of 2.0 inches allowed at end of season.

Net irrigation requirements were also computed for the 1959 and 1961 growing seasons. This was needed to analyze the water supply-crop production data and the irrigation efficiency data collected from the 16 sample farms.

The only part of the irrigated area having watertable levels enabling any appreciable portion of the total moisture requirements to be supplied by capillary moisture was in the 900 acres of native, riverbottom pasture. Here, some 25% of the total April-September moisture requirements were assumed to be supplied from the watertable.

Under future project conditions, it is expected that the acreage of the 1st priority annual crops will generally increase from 31% to 40% of the total, resulting in reduced composite irrigation requirements for nearly all of the irrigated crop area.

Irrigation Supply

Through analysis of the diverted supply records from the Sevier River Water Commissioners Reports for the 28-year period (1934-1961) and from local estimates of the average monthly streamflow available from the various small ungaged tributary drainages, median irrigation supply volumes were determined for each of the irrigation companies in the watershed. The monthly diversion supply volumes were then adjusted to account for the various over-all system efficiencies to obtain the estimated farm headgate supply for each company.

The present, median monthly farm headgate supply for the irrigated cropland served by the three irrigation companies planning major improvement measures in their distribution systems (primarily main canal and lateral lining and irrigation pipelines) is estimated in the following table:

Present Median Farm Headgate Supply 1/

Acre Feet Per Acre

Month	Monroe Irrig. Co.	Annabella Irrig. Co.	Dry Creek Irrig. Co.
March	0.01	0.17	0.22
April	0.13	0.13	0.24
May	0.52	0.42	0.49
June	0.51	0.42	0.33
July	0.56	0.44	0.18
August	0.45	0.34	0.11
September	0.35	0.33	0.09
October	0.21	0.21	0.08
November	0.07	0.25	0.08
Total	2.80	2.71	1.82

1/ One-half of the time, for example 14 years out of 28, the irrigation supply at the farm headgate for the months shown above, has been at least the amount shown. During the remainder of the time, the farm headgate supply has been less than this.

Irrigation Efficiencies

By comparing the amount of water applied and date of each irrigation application with the root zone moisture requirements for that particular crop, approximate irrigation efficiencies for each application were estimated for each sample field.

Each irrigation company service area was studied and evaluated separately. The following ranges in seasonal on-farm irrigation efficiencies were estimated for the various irrigation companies:

Project Increment	Range in %
Present (non-project)	43-50
Future (10-years, "Going" program only)	45-52
Future (10-years, with project)	51-57

Estimates of present on-farm irrigation efficiencies were determined by the experience and judgment of the local SCS technicians, by evaluation of the indicated application efficiencies determined from the 1959 and 1961 sample farm supply - crop requirement data, and from results of prior irrigation field trials and efficiency checks in this and other areas having similar soils, slopes, and irrigation methods and management. Improvements in the average level of efficiencies are expected to be accomplished by the on-farm land treatment program to be installed by the additional technical and educational assistance to be made available and by the improved irrigation supply resulting from the irrigation system improvement measures.

The most commonly practiced method of irrigation is the use of corrugations, especially for grain, hay, and tame pasture. Alfalfa hay is also frequently irrigated by border ditches. Only a limited amount of contour ditches are used. Furrow irrigation is commonly practiced for the annual row crops--potatoes, sugar beets, and corn. The native riverbottom pasture and meadowland is usually irrigated by wild flooding and border ditches. Border dikes and sprinkler systems are not locally accepted practices. Generally the irrigated soils have average to above average infiltration rates, with some of the gravelly areas having quite high rates.

Future improvements in irrigation practices and water management will result from on-farm system reorganization, land leveling, shorter runs and smaller streams, and the use of more automatic, controlled streamsize turnout facilities, especially with the on-farm concrete ditch lining to be installed.

Conveyance and Operational Losses

Representative reaches on seven irrigation company canals were selected for measurement of seepage and operational losses. Measurements made during the 1961 irrigation season, past experience and judgment of the local watermasters and Soil Conservation Service technicians, and results of similar studies on canals and ditches in other areas indicated that present over-all conveyance and operational losses in the various company systems (canals and laterals) range from 21 to 38% of the diverted flows.

With the proposed improvements to the various irrigation company systems, including canal and lateral lining, pipelines, new diversions, water control structures, and measuring devices, it is expected that future over-all conveyance and operational losses in the various company systems will be reduced to a range of from 9 to 37% of the diverted flows.

System Capacity Requirements

Delivery of water to the individual water users under the various company systems will continue to follow the existing demand type system.

Design capacities of the various irrigation company system canal lining will be in accordance with their established water rights, with the optimum standard of having capacity sufficient to meet the peak period irrigation requirements.

Peak period irrigation requirements were based on the average daily requirements determined from the crop having the highest semi-monthly consumptive use. Sugar beets, having a normal consumptive-use requirement of 3.34 inches for the last half of July, have an average daily requirement of 0.21 inches. This was increased by 25% to obtain the peak daily rootzone requirement of 0.26 inches. This rate, when adjusted for the on-farm irrigation efficiency and the irrigation system delivery efficiency, was the basis used for determining the minimum design capacity of the canal lining for the various companies.

The remainder of the company distribution systems not proposing improvement measures generally have present capacities in excess of that required to supply peak daily requirements. Based on the maximum recorded flows diverted into the heads of the five canals diverting out of the Sevier River, they have a present capacity of approximately 1 c.f.s. for every 20-30 acres.

ECONOMICS

Reconnaissance examination of the entire watershed was made with Soil Conservation Service, Forest Service, and Bureau of Land Management personnel and with members of the watershed committee. Flood and irrigation problems were generally defined and located at this time. Further surveys gave a perspective of the most important problems and enabled the formulation of economic survey plans in coordination with hydrologic, sedimentation, and engineering surveys.

Detailed economic surveys were concentrated on:

1. Flood damage surveys on Order-Dugway, Sand-"H", and Bertlesen canyons, and along lower Monroe Creek.

2. Agricultural water management surveys on a stratified sample of the 12,200 acres of irrigated lands.

Further examination was made of the flood fans of Anderson Canyon, Dry Canyon, Corner Canyon, Monroe Creek fans, the Monroe Creek channel through the farming area, Wingate Canyon, Jensen Canyon, Thompson Creek, Circle-Cottonwood Creek, and Maple Canyon fan. Areas in the upper and intermediate watershed, mostly on National Forest and National Land Reserve lands where land treatment was proposed, were examined and effects of the treatment tentatively evaluated so as to guide the planning of land treatment measures and to define those areas where treatment appeared to be the most feasible.

Flood Damage Appraisal

A special committee was selected by the watershed committee to make a study and an inventory of flood occurrences, the general areas of damage, and the items of damage associated with each flood event. This committee made a detailed report in which it listed damaging floods during the period 1917 to 1962. This information was supplemented by data from the U.S.D.A. Sevier Flood Survey. Further detail was developed by interviews with long-time residents of the watershed who had intimate knowledge of various flood events and of measures applied to control them over past years.

The completed inventory listed 9 major and 10 less damaging floods which had occurred in the watershed over the past 45 years. Estimated damages from these flood events totaled nearly $1,200,000. The inventory, by major damage categories and the proportion in each category, is shown below.

Damage Item	Committee	%
Crop and Pastureland	$333,200	28
Other Agricultural	368,900	31
Water and Power Facilities	142,800	12
Roads and Streets	119,000	10
Urban Property	226,100	19
Total Historic Damage	$1,190,000	100

The flood fans and damage areas of Sand-"H", Bertlesen, and lower Monroe Canyons were examined and lands, facilities, and urban and other property susceptible to damage were mapped. By taking into consideration topographic conditions, the location and value of damageable items on the flood plain, information gained from interviews, and the evidences of past flood damages, the recurring types of historic damages listed in the inventory were assigned to the major flood damage areas. Total damages thus assigned were then converted to annual equivalent.

Another approach to the damage appraisal for Sand-"H" and Bertlesen involved the use of a synthetic flood series. Volumes of floodwater and sediment for each frequency size flood were routed through the known flood damage area and the area inundated by each size flood calculated. The sum of incremental damages from floods of 5 to 100-year frequency of occurrence which would occur during the 100-year period was converted to an annual equivalent. The annual damage base calculated by this procedure and those obtained from the inventory of historical damages varied by less than 10% and the more conservative of the two estimates (the historical inventory) was used. The estimated damage base for Sand-"H" was adjusted upward to reflect increased future agricultural damages to the Annabella Extension Canal and to the farmland served by the canal. The projected damage bases and the damage reduction benefits are shown in Tables 5 and 6.

Secondary Benefits-Flood Damage Reductions

Secondary benefits associated with projected cropland damage is included in the damage base and credited as a benefit to the flood prevention structural measures. Direct damages to croplands are measured as an opportunity cost which will develop when service from the upper section of the Annabella Extension Canal and the Monroe City ditch will be suspended due to flood damage. Direct annual damage was calculated as a loss in annual net return from farmlands and gardens, less the annual salvage value of the irrigation

water now being applied to the 90 acres of farmland which would be diverted to other cropland acres. The secondary benefits associated with the adjusted primary opportunity cost will accrue at economic levels beyond the farm. In order to restrict the secondary effects to the local or State level, the secondary benefits were calculated in accordance with the procedure set forth in Watershed Memorandum SCS-57. These include 10% of the primary benefits and 10% of the production costs.

Recreational Benefits

The evaluation of these benefits was based on hunter use of the area which would be served by the upland bird watering facilities. The water developments were conceived as improving the population of doves, pheasants, partridge, chukkar, and sage grouse. Since access roads penetrate the area and the food, cover, and watering conditions appear favorable to the development of the bird population and its use by hunters, it is estimated that there will be at least 300 hunter days use annually. The location, the nature, and the potential of the area dictate the classification of the area as being partially developed. Accordingly, a value of $1.00 per hunter day was used in estimating total benefits.

Agricultural Water Management Analysis

In the reconnaissance surveys of the irrigated lands, the service areas of each irrigation company were delineated; and the amount, distribution, and the methods of water delivery peculiar to each company were outlined. The basic information and the approach used in these determinations are outlined in the preceding Agricultural Water Management discussion.

Basic economic data were derived from a farm survey covering 16 representative farms in the watershed and from census and statistical reporting service data and other local reports. The 16 farms surveyed were stratified to reflect all important physical and economic factors present in the watershed. The farm data included information on farm water supply, detailed production and yield data by fields, size and type of enterprise, soil conditions, and farm practices.

This information was tabulated and summarized along with other pertinent information derived from secondary sources and other reports. After preliminary analysis and organization, the data were presented to a committee composed of representative farmers in the area who participated in further analysis of the information and who also assisted in constructing crop enterprise budgets for principal crops in the watershed. Analyses made through this procedure were refined and documented. These conclusions and determinations were the basis for calculating project effects and for measuring agricultural water management benefits.

Agricultural water management treatment and measures were analyzed at four levels. These were:

1. Total net return from all irrigated lands with the effects of the going land treatment program at the end of the installation period, 10 years hence.

2. Total net returns from all irrigated lands reflecting effects of the going and accelerated program at the end of the installation period, 10 years hence.

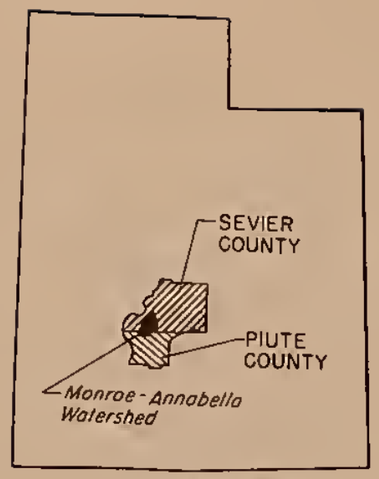
3. Total net returns with going and accelerated land treatment installed plus the effects of the increased farm headgate supply from the lining of irrigation laterals.

4. Total net returns under conditions as outlined in (3) above plus the added farm supply created by main canal lining, irrigation control structures, and diversions.

The monetary values determined for each of the project levels shown above are the product of the per acre crop yields for the various levels of water supply and the net returns associated with the principal crops at the yield levels under future conditions. They reflect the estimated direct effects of the measures which will be installed under the going and accelerated program and the associated effects of an increased application of improved farm technology as induced by the project. Differences between total net farm returns at the levels analyzed as described above were taken as direct primary agricultural water management benefits. These values are shown below.

	Total Net Farm Return	Benefits
Without Project Measures	$372,420	
With Project Measures	483,205	$110,785
Less Associated Costs of Land Treatment Measures		15,585 1/
Benefits From Structural Measures for AWM		$ 95,200

1/ Amortized Over 25 Years



LOCATION MAP

LEGEND

- Canal Lining (Main & Laterol)
- Diversion Dam
- Pipe Line
- Debris Basin with Levees
- Stream Bank Protection
- Stabilization of Critical Areas
- Area Benefited
- Drainage Area Controlled by Structures
- Boundary - Fishlake National Forest

SCALE IN MILES 0 1 2 3

FIGURE 1
WORK PLAN

PROJECT MAP

MONROE - ANNABELLA WATERSHED

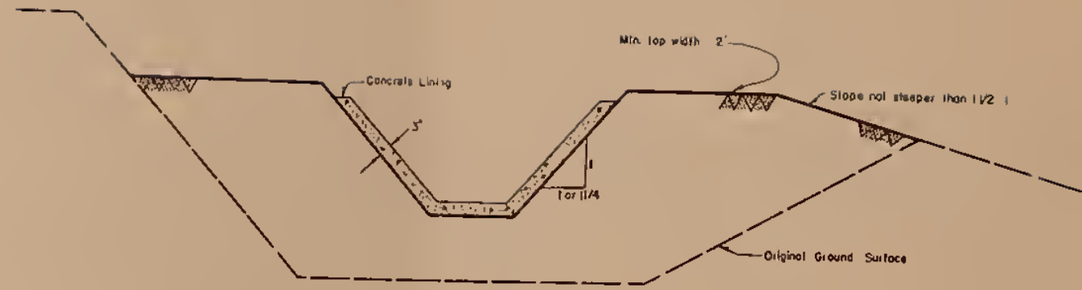
SEVIER AND PIUTE COUNTIES, UTAH

PRELIMINARY PLANS

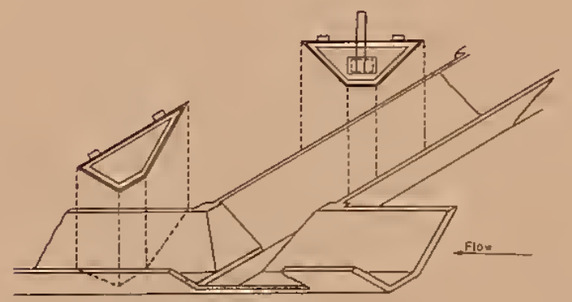
U S DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by _____ Date 8-62 Drwg No. 7-E-17360-N
Sheet ___ of ___ Sheets

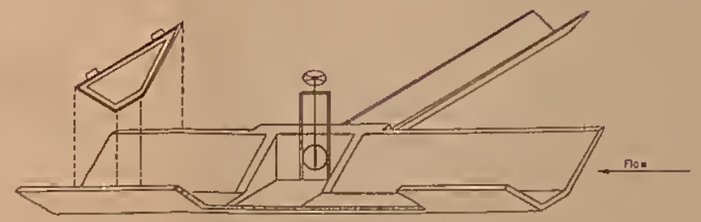
M-3765



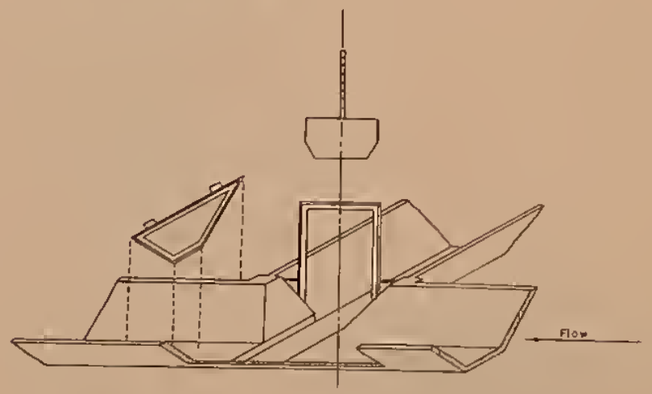
TYPICAL CANAL SECTION



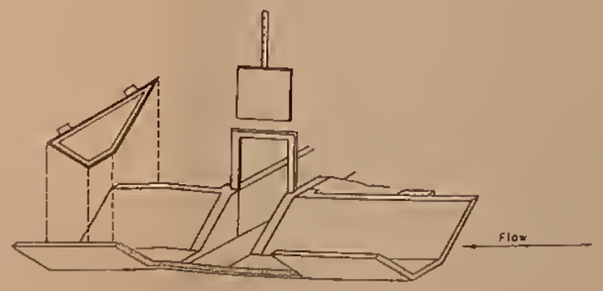
TRAPEZOIDAL CHECK GATE



ROUND CAST IRON SCREW GATE



TRAPEZOIDAL SLIDE GATE



RECTANGULAR SLIDE GATE

TYPICAL TURNOUT STRUCTURES

FIGURE 2

WORK PLAN

CANAL LINING

MONROE - ANNABELLA WATERSHED

SEVIER COUNTY & PIUTE COUNTY S C D'S, UTAH

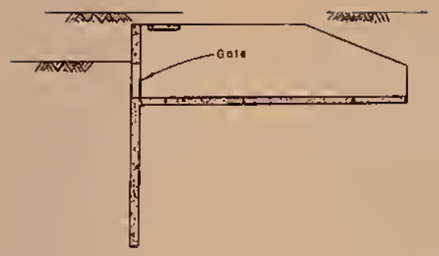
PRELIMINARY PLANS

DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by G.G. G.H. Date 6/62 Drwg. No. 7-E-17300

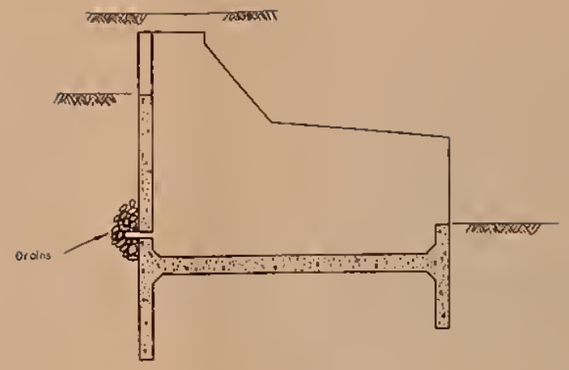
Sheet 1 of 1 Sheets

M-3765

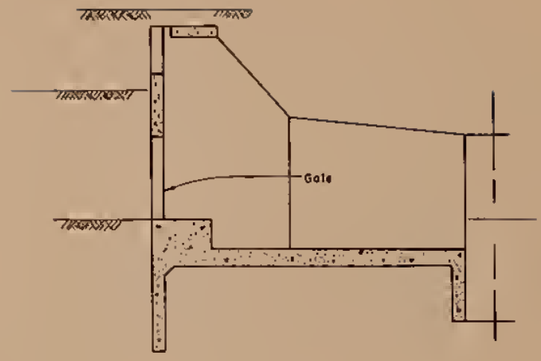


SECTION C-C

8 0 8 16
SCALE IN FEET

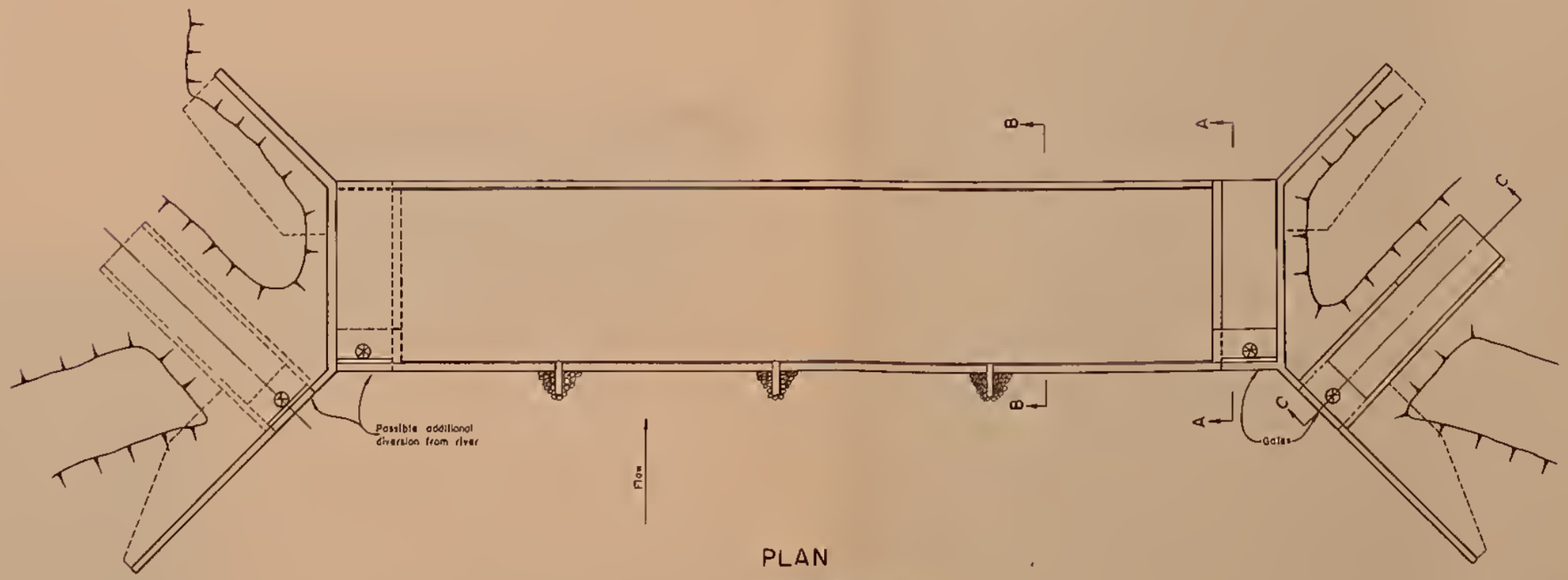


SECTION B-B



SECTION A-A

6 0 6 12
SCALE IN FEET



PLAN

8 0 8 16
SCALE IN FEET

FIGURE 3

WORK PLAN

TYPICAL DIVERSION FROM SEVIER RIVER

MONROE - ANNABELLA WATERSHED

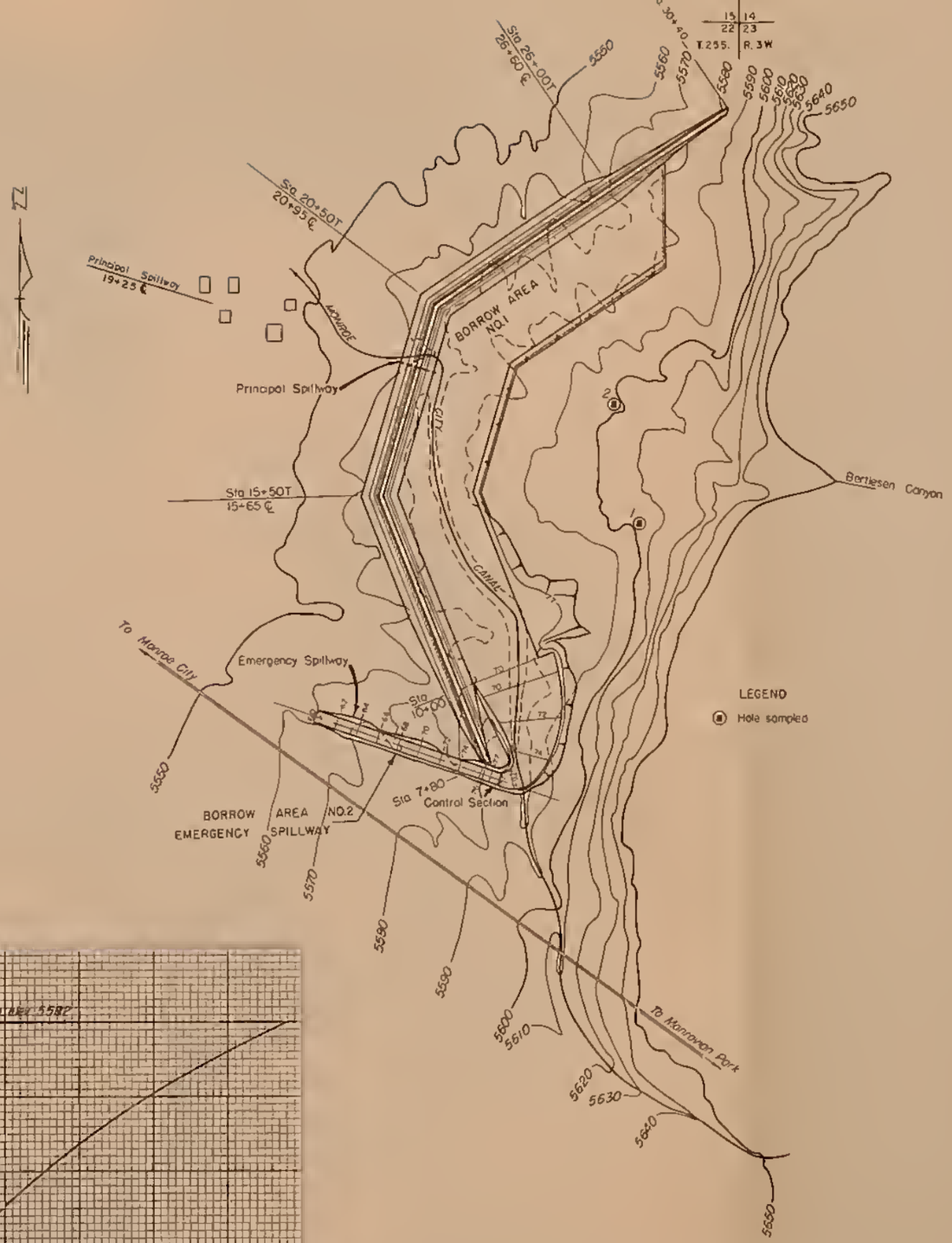
SEVIER COUNTY & PIUTE COUNTY S.C.D'S., UTAH

PRELIMINARY PLANS

DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

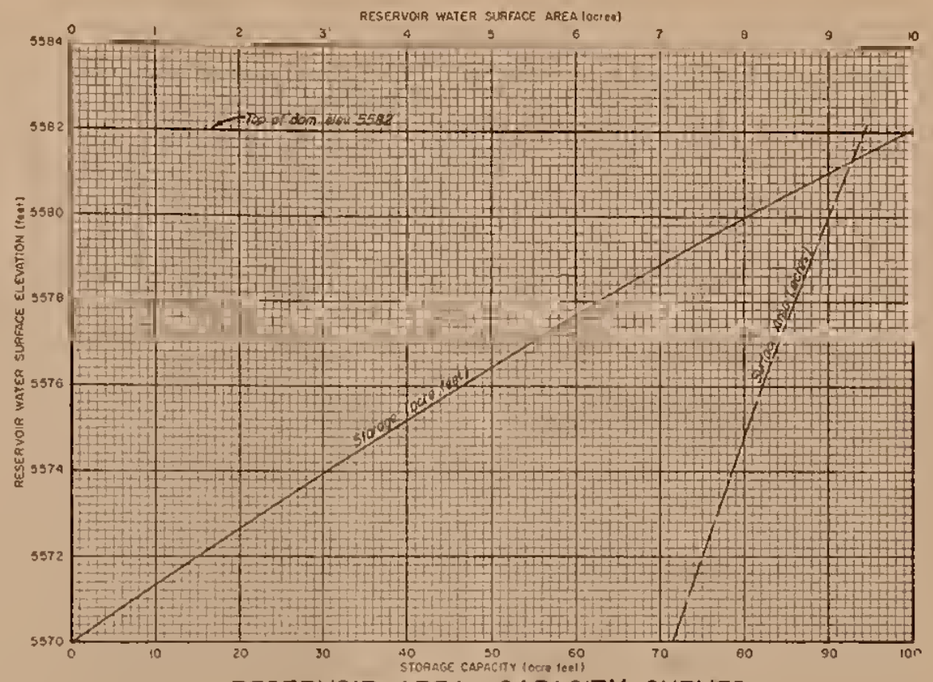
Prepared by G.C.&G.H. Date 6/62 Drwg. No 7-E-17301
Sheet 1 of 1 Sheets

M-3765

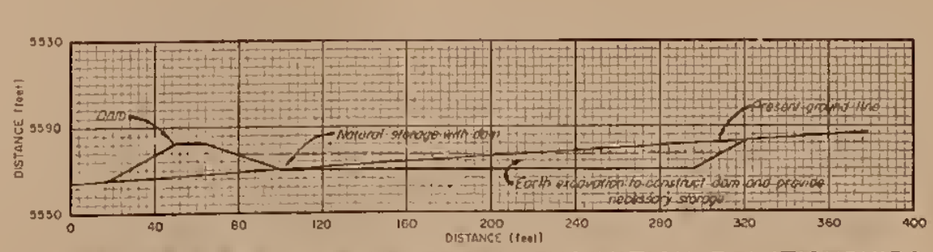


PLAN

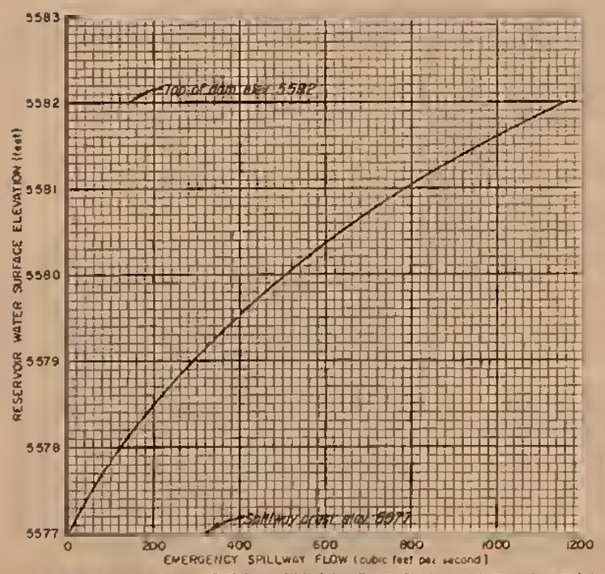
SCALE IN FEET



RESERVOIR AREA - CAPACITY CURVES



DAM EMBANKMENT & UPSTREAM EXCAVATION RELATIONSHIPS FOR SEDIMENT STORAGE ON STEEP SLOPES



EMERGENCY SPILLWAY DISCHARGE CURVE

FIGURE 4

WORK PLAN

BERTLESEN CANYON DEBRIS BASIN

MONROE - ANNABELLA WATERSHED

SEVIER AND PIUTE COUNTIES, UTAH

PRELIMINARY PLANS

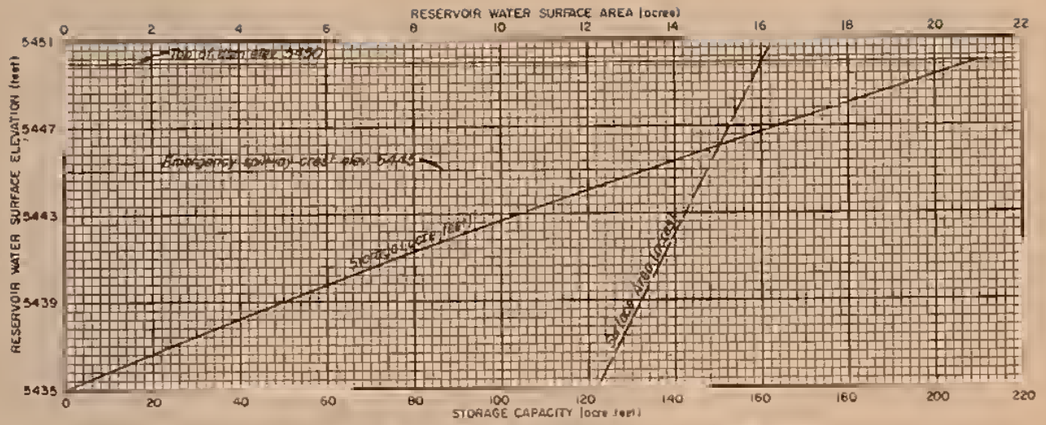
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

J T L
G E G

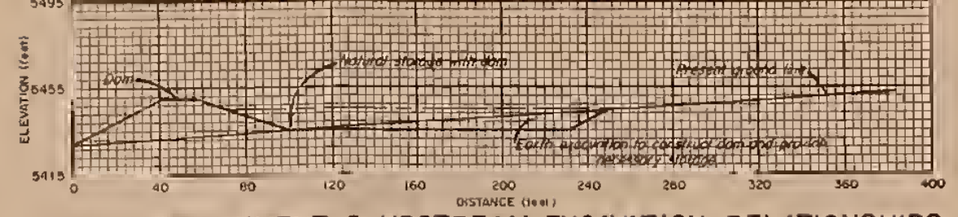
Prepared by B L B Date 8-62 Drwg No. 7-E-17360-N

Sheet of Sheets

M-3765



RESERVOIR AREA - CAPACITY CURVES



DAM EMBANKMENT & UPSTREAM EXCAVATION RELATIONSHIPS FOR SEDIMENT STORAGE ON STEEP SLOPES

PLAN

SCALE IN FEET

EMERGENCY SPILLWAY DISCHARGE CURVE

FIGURE 5

WORK PLAN

SAND & "H" CANYON DEBRIS BASIN

MONROE-ANNABELLA WATERSHED

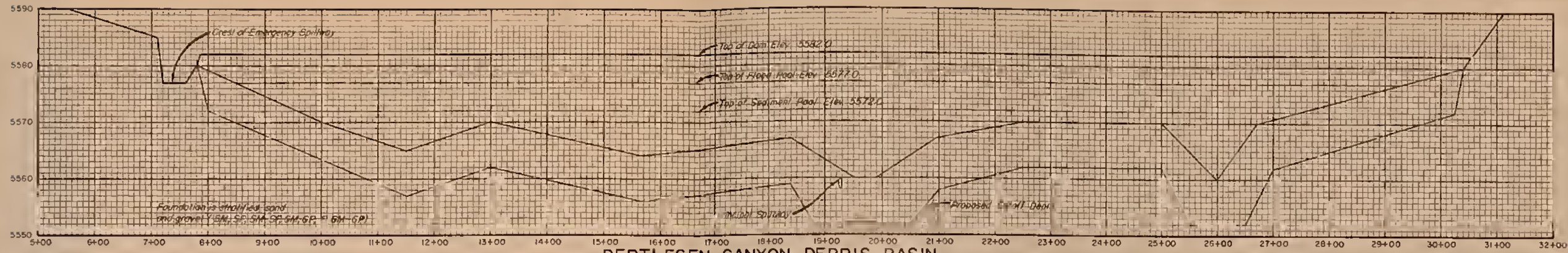
SEVIER AND PIUTE COUNTIES, UTAH

PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

J.T.L.
G.E.C.
Prepared by BLB Date 8-62 Drwg No. 7-E-17360-N
Sheet of Sheets

M-3765

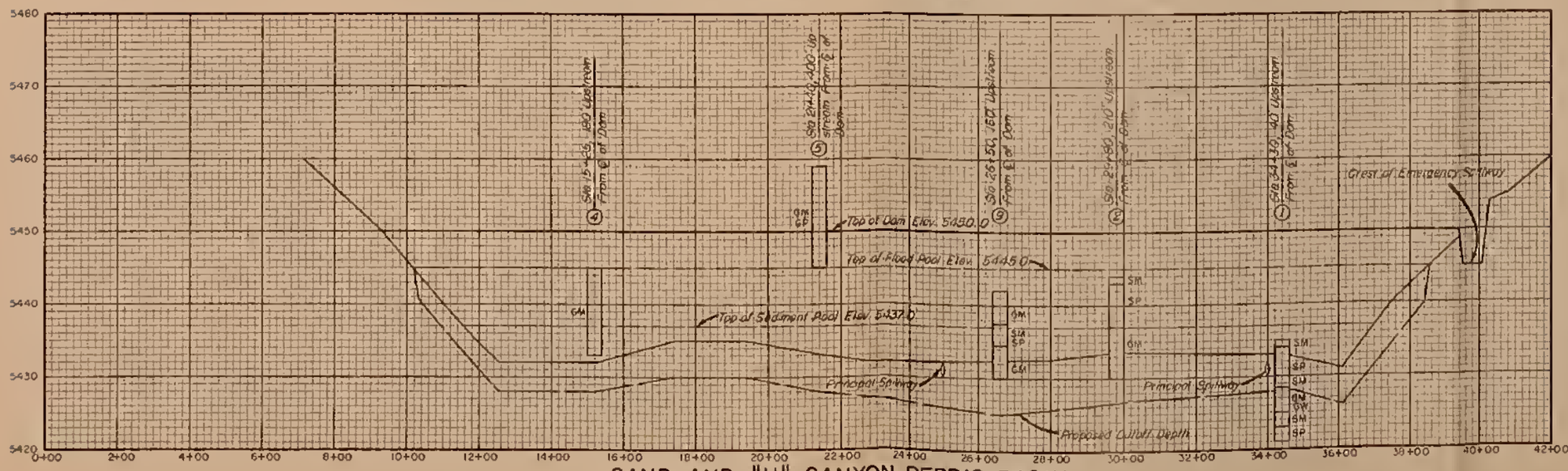


BERTLESEN CANYON DEBRIS BASIN

PROFILE AND GEOLOGIC SECTION : CENTERLINE OF DAM

SAND AND "H" CANYON DEBRIS BASIN DIKE

PROFILE AND GEOLOGIC SECTION : CENTERLINE OF DAM



SAND AND "H" CANYON DEBRIS BASIN

PROFILE AND GEOLOGIC SECTION · CENTERLINE OF DAM

LEGEND · Unified Soil Classification System Symbols

GW Well graded gravels, gravel-sand mixtures

GM Silty gravels, gravel-sand-silt mixtures

SP Poorly graded sands

SM Silty sand

FIGURE 6

WORK PLAN

SAND & "H" CANYON & BERTLESEN CANYON DEBRIS BASINS

MONROE-ANNABELLA WATERSHED

SEVIER AND PIUTE COUNTIES, UTAH

PRELIMINARY PLANS

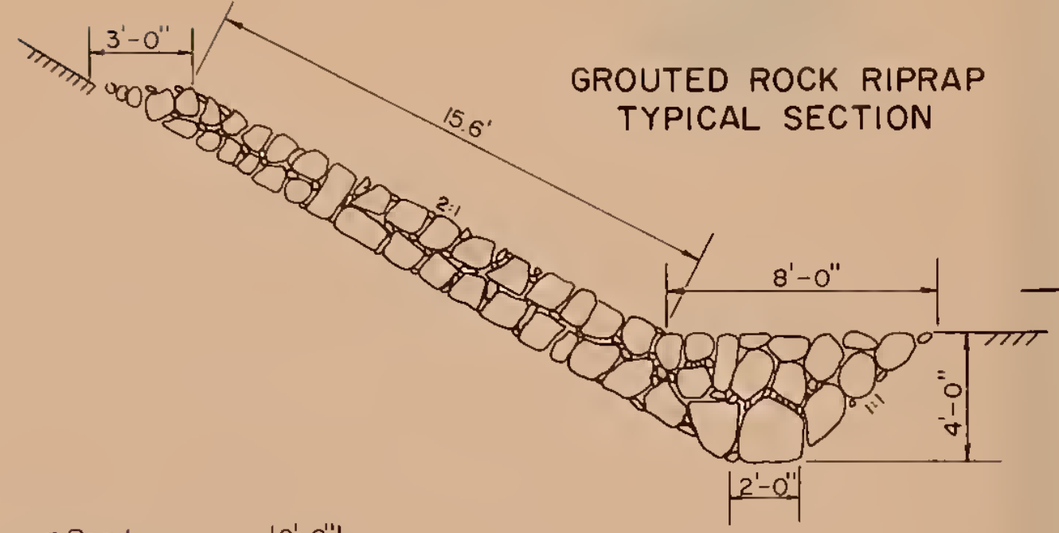
U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by BLB Date 8-62 Orwg No. 7-E-17360-N

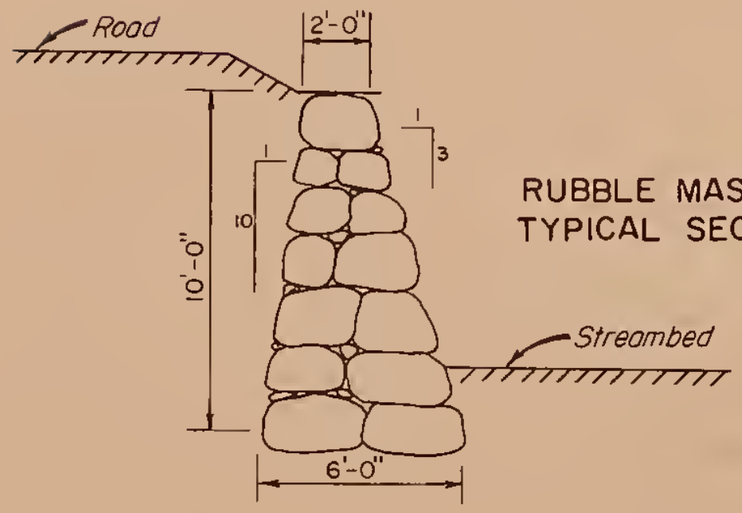
Sheet of Sheets

M-3765

GROUTED ROCK RIPRAP TYPICAL SECTION



RUBBLE MASONRY TYPICAL SECTION



LEGEND

× Rubble masonry

△ Grouted rock riprap

LOCATION MAP

SCALE IN MILES

FIGURE 7

WORK PLAN

MONROE CREEK STREAMBANK PROTECTION

MONROE-ANNABELLA WATERSHED

SEVIER AND PIUTE COUNTIES, UTAH

PRELIMINARY PLANS

U.S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

Prepared by_____ Date 8-62 Drwg. No. 7-N-17360

Sheet__ of__ Sheets

M-3765